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FORTH AND CLYDE SHIP CANAL
IN RELATION TO
THE DEVELOPMENT
OF COMMERCE.

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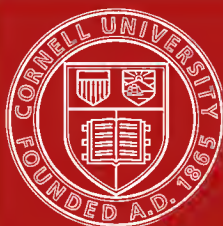
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FORTH AND CLYDE SHIP CANAL

IN RELATION TO

THE DEVELOPMENT OF COMMERCE.

BY

J. LAW CRAWFORD,

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Member of the Faculty of Procurators of Glasgow;

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P R E F A C E .

SOME of the leading local, national, and international aspects of the case for the Provisional Committee of Promoters of the proposed waterway between the Clyde and the Forth are now presented. In support of the case many eminent commercial, scientific, naval, and military authorities have been cited. From their views on (1) the present and future condition of commerce, (2) the defences of the United Kingdom, and (3) the influence of waterways in developing that commerce, and in adding to the security of the country in the event of war, those interested in the project will be able to arrive at a sound conclusion regarding its national utility and its prospective financial success.

On the strength of the evidence of those authorities the case is respectfully submitted to the judgment of the press and the public.

The author desires to gratefully acknowledge the valuable aid received from many friends and others interested in the promotion of the project. His thanks are specially due to Messrs. Charles John Wilson of Deanfield, Hawick, manufacturer, V.P., South of Scotland Chamber of Commerce, whose articles in the *Economist*, about a year ago, created such a powerful revival of public enthusiasm in the movement; James Deas, M.I.M.E., F.R.S.S.A., engineer, Clyde Navigation; J. H. S. Crompton, general manager, Lancashire

and Yorkshire Bank, Limited, Manchester; A. Orr Deas, M.A., LL.B., advocate; F. Towers Cooper, M.A., LL.B., advocate; Marshall Stevens, general manager, Manchester Ship Canal Company; James Deas, junior, C.E., Manchester Ship Canal; James Duncan of Twechar; W. Burt Wright of Auchinvole Castle; J. W. Burns of Kilmahew; R. T. Moore, C. and M.E.; John Todd, M.E.; W. Coutts Fyfe, resident secretary, Westminster Fire Office; Professor Jamieson, M.Inst.C.E., F.R.S.E.; W. D. Cairney, C.A.; J. Nigel Stark, M.B., F.F.P.S.G.; C. P. Hogg, M.Inst.C.E.; Campbell Hart, S.Inst.C.E.; and John Young, F.G.S., Glasgow University.

146 WEST REGENT STREET,
GLASGOW, *28th February, 1891.*

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FORTH AND CLYDE SHIP CANAL

IN RELATION TO

THE DEVELOPMENT OF COMMERCE.

LOCAL ASPECTS OF THE PROJECT.

CHAPTER I.

THE DEVELOPMENT OF LOCAL TRADE.

THE PROPOSED SHIP CANAL. The attention of the public has been frequently directed to projects for uniting the Atlantic and German Oceans, the two most frequented seas in the world, by means of a ship canal through central Scotland. The numerous proposals, in their turn, have, for a time, aroused local interest and enthusiasm, but being unaccompanied by definite plans, or sufficient data, to enable the public to judge of their respective merits, they have, invariably, been abandoned without practical result. A definite plan is now submitted for the construction of a ship canal 29 miles 6 furlongs and 196 yards long, 26 feet deep, and 100 feet wide at the bottom, capable of bearing on its waters large ocean-going merchant steamers and men-of-war, and extending, in a direct line across the narrowest part of Britain, from Yoker on the Clyde to Grangemouth on the Forth. This route has been surveyed by engineers of high standing, and their report, printed in the Appendix, clearly demonstrates the practicability of the project from an engineering point of view. The initial difficulty has thus been overcome. The satisfactory solution of the remaining questions relating to the commercial utility, and the prospective financial success of the project, will make the Forth and Clyde Ship Canal an accomplished fact within the next decade. These questions the author has examined from every available point of view, together with the direct and indirect evidence of many eminent authorities.

bearing upon the various divisions of the subject. The results of the examination are embodied in the following pages.

OBJECT OF THE PROJECT. The main object in view in promoting this project is the development of local, and the protection of national commerce. From the success of allied projects in the same district and elsewhere in the past, there is every reason to believe that the proposed waterway would increase the volume of commerce; aid in maintaining and protecting that commerce against foreign competition in times of peace, and foreign acquisition in the event of war; and that it would also, in itself, prove a highly remunerative undertaking.

ADMIRAL MAYNE ON COMMERCE. Rear-Admiral R. C. Mayne, C.B., M.P., in the course of a paper on the protection of commerce, read by him before the London Chamber of Commerce, on 28th November last, said: "When I ask myself what protection of commerce comprehends, I am forced to ask an even more important question. What does it not comprehend? It is the very life-blood of the country. The empire is commerce." In view of this declaration, given from the chief seat of the world's commerce, and in the presence of many naval and military authorities, including Lord Brassey, Lieutenant-General Sir Edward Hamley, M.P., Sir Edward J. Reed, M.P., Admiral Sir Leopold M'Clintock, Vice-Admiral Sir George Tryon, Admiral Sir Vesey Hamilton, and others, any project which promises to aid largely in the protection of commerce is worthy of serious consideration.

REPEATED IMPULSES NECESSARY TO COMMERCE. Commerce may be said to be the mainspring of the complex social organisation of the present day. Like the mainspring, it requires fresh impulses periodically. Its movements have a tendency to clog, as the impetus, derived from the preceding impulse, dies away. The canalising of the Clyde imparted an impulse to local trade that has helped to keep it moving smoothly for a long period. The rapid development of railways imparted another impulse that also tended to provide the necessary augmentation. New outlets for commerce have been gradually opened up, and the increased facilities have created an enormous amount of additional trade. One impetus has given birth to another. The deepening of the Clyde and the introduction of railways have brought the mineral resources of the district into greater use. Glasgow, now the centre of Scottish trade, has attained her position by the opportune impulses imparted to the primary factor in her existence.

CAUSE OF TRADE DEPRESSIONS. It has been evident, however, from the fluctuating depressions and partial stoppages, frequently experienced in the commerce of the district during the past ten or twelve years, that the movements have become over-weighted. The advantages afforded by the existing waterways, railways, and other modes of transport, have been gradually taken

up by a larger number of workers, and competition has consequently increased. While the general trade of the country and the district has developed enormously, the means of production have developed in still greater proportions, and hence the mass of the people have experienced frequent depressions.

NEW TRADE ROUTES NECESSARY. It will be admitted that the gradual increase of trade, in proportion to the growth of the population and the demands of modern civilisation, is absolutely essential to the well-being of every class of the community. It will be admitted that competition is becoming keener every year, and that all classes are suffering more or less from the strain. It will be admitted that it is highly desirable that means should be devised for imparting, if possible, another impulse to trade, in order to relieve the recurring states of tension. That impulse should be similar to those that have been tested, and found effectual, in the past. New channels for trade have been invariably successful in central Scotland during the last fifty years. As this project would provide a new channel on a comprehensive scale, and reduce the tariffs between central Scotland and northern Europe and America, the chances are strongly in favour of equal, or even greater, success. The present surplus power of production, which, instead of being a benefit, drags the markets, lowers legitimate profits, ties up capital, and impedes the efforts of individual traders, would thereby find scope in new directions. The already established trades would be relieved, to a very large extent, from the present burden of over-production, and consequently benefited; and at the same time new industries would be created and fresh markets formed.

FOREIGN COMPETITION. A perpetual commercial war is being waged between this and continental countries. The latter are gradually extending their operations, and frequently gaining ground in British home and foreign markets, chiefly by being able to quote lower prices. To enable this country to maintain its leading position every means should be adopted to reduce prices, without unduly affecting profits. The ship canal, by reducing freights on raw materials and articles of bulk, would conduce to this result, and aid the country in maintaining its commerce, and extending its operations to markets presently closed against it.

ORIGIN OF LOCAL PROSPERITY. The progress and prosperity of Glasgow, during the present century, is primarily due to the proximity to the ocean, on the one hand, and the mineral resources of the district, on the other. The minerals gave rise to manufactures, the manufactures to exportation, the exportation to improved waterways, and the waterways to railways. These adjuncts, acting and reacting upon each other, have created one of the chief commercial centres of the world. At the end of last century the valley of the Clyde possessed all the natural advantages for the development of trade that

are now manifest. These advantages, however, were practically useless while the valley remained in its natural state. The deepening of the Clyde turned them to account, and increased trade to such an extent that, according to a high authority, after quoted, the cost of deepening the river has been repaid many thousand-fold. The valley of the Kelvin to-day may be compared to the valley of the Clyde one hundred years ago. It possesses many natural commercial advantages that are practically useless while it remains in its present condition. To turn these advantages to commercial account the valley must be rendered capable of transporting large vessels. If this is done it is reasonable to anticipate, from the evidence available, that the deepening of the Kelvin will yield as satisfactory results as the deepening of the Clyde. The opening of a channel to the east, as deep as the present channel to the west, would be of enormous advantage to the industries already established in the district. Manufacturers would be placed on a more equal footing with their foreign rivals, and the whole trade of the country would be stimulated. That the district has an almost unlimited capacity for the development of trade in the future will be evident from the statistics of its minerals, and the references to its established industries.

<p>LOCAL BENEFITS DURING CONSTRUCTION OF CANAL.</p>	<p>The construction of the ship canal, and the consequent addition of several millions to the circulation of money in this district, would, of itself, be productive of a period of prosperity in which all classes of the community would share. The canal works would give direct employment to thousands, and indirect employment to hundreds of thousands, of the population. New dwellings and manufactories would be required, bringing renewed activity into the ranks of the building and allied trades. The demand for increased supplies of all kinds of commodities would give an impetus to wholesale and retail houses, while the shipping and railway companies would share very largely in the benefits. These deductions are founded on the results of similar schemes both at home and abroad, and, particularly, on the results that have followed the canalising of the Clyde—results strikingly manifested by the extraordinarily rapid commercial advance of the city.</p>
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<p>PARLIAMENTARY ACTION.</p>	<p>Mr. E. Clements, Secretary to the Railway and Canal Traders' Association, and to Lord Henniker's Railway Rates Committee, Member of the International Congress on Inland Navigation, in his paper to the Congress, says: "<i>While the volume of our trade has increased, profits have decreased; competition with other countries has become infinitely keener, and cheaper transport is now a vital necessity. This necessity is really a question of public policy,</i> and, in seeking relief for trade, it may be well to abjure the old methods and adopt others more speedy and more adapted to present requirements. A method proposed is the acquisition of canals by municipal and other similar authorities, or by public</p>
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trusts specially constituted. Canal controllers of this description would not enter upon the carrying business, but would be simply toll-takers and conservators. *For purely local purposes nothing could be much better than a properly elaborated scheme of this sort*, and perhaps the clearest proposal that has yet been made is that contained in 'A Bill to enable local authorities to acquire, regulate, and construct canals'; brought into the House of Commons last year (1889) by the Hon. Philip J. Stanhope, Dr. W. A. Hunter, and other Members of Parliament interested in the question. By this Bill it is provided that any local authorities who desire to acquire or construct canals may apply to the Board of Trade for a provisional order authorising them to do so."

LOCAL COMMITTEES. The maintenance of the trade of the district in the future depends upon cheaper transport. Mr. Clements, from his official position, speaks with authority when he declares that cheaper transport is "a vital necessity." As a question of "public policy," it is of importance to the Parliamentary representatives, and to the City, County, and Town Councillors of the districts that would be benefited. Electors, by their votes and influence, can secure this "vital necessity." The question can be solved by the formation of Local Committees in the various districts. As the material prosperity of every member of the community depends, directly or indirectly, upon the development of trade; and as the development of trade depends, in turn, upon the opening up of new channels, and the reduction of freights, each individual has a personal interest in this project, and in the formation of committees to consider and report upon the best mode of carrying it out.

BASIS OF ESTIMATE OF RESULTS OF PROJECT. To form a reasonable estimate of the probable effect of this project upon the development of the future trade of the district it is necessary to consider (1) the results of the canalising of the Clyde, and the success of the present Forth and Clyde barge canal; (2) the geological features of the route, and the extent of the mineral resources of the district; (3) the development of the shipping trade of central Scotland in the past; (4) the capacity of the district for development in the future, by reason of its innumerable established industries; and (5) the influence of the project upon the railways, and the inland carrying trade.

CHAPTER II.

SUCCESS OF ALLIED PROJECTS.

RESULTS OF THE CANALISING OF THE CLYDE.

MR. DEAS ON "THE CLYDE." The strongest arguments that could be used in support of this project for deepening the Kelvin are to be found in the marvellous success that has attended the deepening of the Clyde. In tracing the development of trade, due to the canalising of the latter river, the author will avail himself largely of the materials that have been kindly placed at his disposal by the highest authority on the subject, Mr. James Deas, M.I.M.E., F.R.S.S.A., Engineer, Clyde Navigation. Mr. Deas, in a paper on the River Clyde, read in Glasgow before the Institution of Naval Architects, on 24th July, 1888, referring to the progress of the harbour and commerce of Glasgow, says: "Three hundred years ago it cannot have entered into the minds of the most sanguine and far-seeing citizen of *Glasgow* that his city would ever become one of the leading ports of Great Britain, *situated*, as it was, *on a shallow, sand-choked stream*, upwards of twenty miles from deep water at Greenock, and its usual port, Irvine, in Ayrshire, twenty-nine and a half miles by land from Glasgow, from which merchandise was conveyed to and fro by lighters and pack horses." The quotations in this chapter not otherwise acknowledged are from the paper referred to.

EFFECTS OF DEEPENING THE KELVIN. The Kelvin to-day is a shallow stream useless for commerce. Its deepening, however, would have the effect of directing the traffic of the North Sea to Glasgow, as the Clyde directs the traffic of the Atlantic. The project, at its inception, would have the advantage of the fact that an enormous traffic now exists, ready to benefit and to be benefited; whereas, in the case of the Clyde, while in its natural state, practically no traffic existed. Trade goes where trade is. On new soil an import and export business is, even when backed by lavish outlay and large reserves of capital, of tardy growth. Here the business exists in a crowded condition awaiting new outlets. The deepening of the Clyde has created the traffic, and paved the way for success in the deepening of the Kelvin.

GLASGOW'S OFFER TO DUMBARTON, AND THE BUILDING OF PORT-GLASGOW. *"The magistrates of Glasgow, with that doggedness characteristic of Scotchmen, however, determined to have a port nearer home, and in 1653 made overtures to the magistrates of Dumbarton to purchase ground for an extensive harbour there, but these were declined, on the ground that the great influx of mariners and others would raise the price of provisions on the inhabitants; they, therefore, in 1662, purchased 13 acres at Newark, on which they afterwards laid out the town of Port-Glasgow, built harbours, and constructed from the design of James Watt, the first graving dock in Scotland, recently enlarged. While thus fostering Port-Glasgow, they still hankered after accommodation for ships at Glasgow, and in 1688 built a quay at the Broomielaw."*

The prospects of financial success, in converting the inland town of Glasgow into an Atlantic port, must have been small in comparison with the prospects of success in making the great city of Glasgow a North Sea port in, say, 1900. The offer to Dumbarton, and the building of Port-Glasgow, indicate the difficulties with which Glasgow in those days had to contend. "Doggedness" triumphed over these difficulties, and compelled a success, of which the commercial position of the city to-day is the evidence. The deepening of the Kelvin would simply maintain the continuity of the policy inaugurated by the magistrates of Glasgow in 1658.

QUAYAGE, REVENUE, AND TONNAGE OF THE CLYDE. *"The extension of the harbour synchronised with the deepening of the river, so that, while in 1800 the quayage was only 382 yards long, the water area of the harbour only 4 acres, the revenue of the Clyde Trust £3,400, and the Customs revenue £427, the length of the quayage is now 10,839 yards, or 6 miles 275 yards, the water area 154 acres—fully one-half of the latter, and of the total quayage having been added since the author became Engineer of the Trust—the Trust revenue £287,933, and the Customs revenue £1,012,051. The total imports and exports for the year ending June 30, 1887, amounting to 3,723,058 tons, while the registered tonnage of vessels arriving at the harbour was 3,118,515 tons."* From the accounts of the Trustees of the Clyde Navigation, for the year ended 30th June, 1890, the goods imported and exported amounted to 4,794,562 tons, while the tonnage of vessels arriving at the harbour amounted to 3,496,848, the total amounting to 8,291,410 tons; an increase of 1,449,837 tons in three years.

The ship canal would afford, practically, unlimited scope for the extension of quayage along its banks. There is no reason why the whole waterway between Yoker and Grangemouth should not be, practically, one elongated dock. The minerals are there, the labour is close at hand, the supply of water is ample, and the formation of the country is such that the engineering difficulties are trivial.

The deepening of the Clyde has, during the present century, increased the customs revenue of Glasgow from £427 to £1,012,051, per annum. In view of the traffic from northern Europe, it is not unreasonable to expect that the extension of the Clyde waterway to the Forth would, in time, double this revenue. The Government, by advancing a sum equivalent to two or three years' revenue of the Clyde, at a moderate rate of interest, or by guaranteeing a dividend of $2\frac{1}{2}$ or 3 per cent. on the cost of the ship canal, would obtain a large return in the shape of increased customs, and would at the same time aid in the speedy completion of a necessary national work.

It is reasonable to expect that if the Canal were available in 1900, its traffic from local, national, and international sources would equal in extent the present local traffic of the harbour of Glasgow. At rates similar to those now charged on the Clyde, a traffic of 8,000,000 tons would render the undertaking a highly remunerative investment.

RESULTS OF DEEPENING THE CLYDE. *"These improvements have raised Glasgow, within the short period of 88 years, from a second-rate inland provincial town, with a population of 77,000, to be the second city of the Empire, with a population (including its suburbs) of 770,000; the chief seaport of the West of Scotland; increased the value of lands on the river's-sides, from Glasgow seaward, a hundred-fold; created the burghs of Govan, Partick, and the numerous other burghs which environ Glasgow; given wealth to thousands, and the means of life to hundreds of thousands of the inhabitants of the northern portion of the kingdom; and emphasised in a marked degree the local epigram, 'Glasgow made the Clyde, and the Clyde has made Glasgow.'"*

The deepening of the Clyde has had an extraordinary influence on the growth of Glasgow. The deepening of the Kelvin would bring similar influences to bear on the whole district of central Scotland. From the national character of the work even greater results may be anticipated.

The deepening of the Clyde has increased the value of lands enormously. The Manchester Ship Canal Company have acquired tracts of land for feuing purposes along the banks of their canal. A similar acquisition could be made in connection with this project. Sites upon the banks of the Forth and Clyde Ship Canal would be eagerly acquired, for the reasons that (1) freights for coal and other minerals and raw materials, from home and foreign ports, would be very low; and (2) manufactured goods could be shipped direct from the works, by the shortest routes, to the principal markets of the world. In view of these advantages the value of the land would, as on the banks of the Clyde, be increased a hundred-fold, and a large revenue would accrue from this source.

The deepening of the Clyde has given wealth to thousands, and the means of life to hundreds of thousands. The continuation of the work which has

conferred such inestimable benefits is worthy of the most serious consideration. There is no reason why the remaining half of the work required to complete the canal from sea to sea should not be productive of as beneficial results as the part of the work already accomplished.

ADVANCE OF SHIPOWNING ON THE CLYDE. "While in 1656 Commissioner Tucker stated that there were only twelve vessels belonging to the merchants of the port" (total tonnage, 957), "the Board of Trade statistics for last year (1887), show Glasgow to be *the third largest shipowning port in the kingdom*, with 1,487 vessels of an aggregate tonnage of 1,141,037, against Liverpool with 2,350 vessels of 1,820,375 tons, and London with 2,488 vessels of 1,156,682 tons; but if Greenock, with its 331 vessels of 229,912 tons, was classed with Glasgow, as it well might be, it would give the Clyde 1,818 of 1,370,949 tons, and thereby make it *the second largest shipowning river in the kingdom.*"

Considering the great extent and value of the shipping belonging to the Clyde, it is anomalous that it should continue to be practically deprived of the advantages of trading with the North Sea ports by a barrier which could be comparatively easily removed. The development of the shipping trade, following the removal of this barrier, would probably place the Clyde first on the list of shipowning ports. Such a result would not be so extraordinary as that which has placed it before the Thames in this respect.

VOLUME OF THE CLYDE SHIPPING TRADE. "As to the volume of trade, Glasgow, in regard to entrances and clearances of ships on foreign voyages, stands sixth in the list of British ports, with 2,324 vessels of 2,336,958 tons; being surpassed by London, Liverpool, Cardiff, the Tyne ports, and Hull; while, if the coasting traffic is included, *Glasgow also stands sixth with 17,163 vessels and 5,539,266 tons; but if Greenock were counted, the Clyde would stand fifth with 27,067 vessels of 7,597,341 tons.*"

At present this enormous traffic of the Clyde is influenced by Glasgow and Greenock alone. If the through canal were available, all the ports on the east and west coasts would influence the traffic and augment its volume. The ports which now rank before Glasgow, in respect of the volume of trade, would all contribute to place it higher, if not first, on the list. These considerations lead to the conclusion that the traffic of the canal would exceed that of the Clyde at present.

THE CLYDE A GOLD-PRODUCING STREAM. "*In no instance have river improvement works been attended with such beneficial results—commercial, industrial, and social—as this of the Clyde, which has in recent years been indeed a gold-producing stream.*"

The completion of these improvement works, and the extension of their sphere of influence to all the ports of northern Europe, would multiply the

commercial, industrial, and social benefits, and render the Kelvin, the Carron, and the Forth, as in the case of the Clyde, metaphorically, gold-producing streams.

FINANCIAL
SUCCESS OF
DEEPENING
THE CLYDE.

Mr. Deas, in his exhaustive work on the river Clyde, referring to the improvements on the river from Glasgow to Port-Glasgow, says: "In tracing *these improvements*, the writer has tried to show that while much money and labour have been expended on them, they *have repaid the outlay many thousand-fold*, and, in a comparatively short period, raised the city of Glasgow from an obscure salmon fishing village, to the position of *one of the great commercial centres of the world.*"

"The navigable facilities thus realised, combined with the mineral resources of the district, have made its banks the seat of the largest ship-building trade in the world. Seldom has engineering skill been productive of so much commercial success, perhaps never has it contributed more to individual prosperity than it has done in the improvement of the river Clyde."

As the Clyde ship canal to the west has repaid its cost many thousand-fold, established the largest shipbuilding trade in the world, contributed greatly to individual prosperity, and converted an obscure village into the second city of the empire, it is reasonable to conclude that, with a world-wide commerce now established, the continuation of the same canal to the east, through a country possessing even greater advantages, would increase, to a proportionate extent, the extraordinary and unexpectedly successful financial results already achieved.

REVENUE
OF THE
CLYDE TRUST.

The following figures are derived from the abstract statement of the annual revenue of the Clyde Trustees. They show the rapid development of the commerce of the district in recent years, and point to the success that awaits similar undertakings for providing new channels and increased facilities for trade: In 1770 the Clyde Trust revenue only amounted to £117 0s. 10d.; in 1800 it reached £3,319 16s. 1d.; in 1850, £64,243 14s. 11d.; in 1870 it had increased to £164,093 2s. 10d.; in 1880, £223,709 0s. 8d.; and last year, 1890, the large revenue of £356,202 11s. 3d. was reached. The total revenue for the period from 1770 to 1890 amounts to £8,166,472 9s. 4d.; and the total expenditure for the same period amounts to £12,714,942 14s. 0d. Here is an example of enterprise, based on calculation, and crowned with a signal success. Nature has provided in the Kelvin valley scope for the continuation of the work; the development of commerce has provided the means for making the work a financial success.

SUCCESS OF THE PRESENT BARGE CANAL.

DIVIDENDS OF 25 PER CENT. The history of the present Forth and Clyde barge canal shows that a waterway through central Scotland, of a sufficient capacity to meet the commercial requirements of the time, is capable of creating a great traffic, and becoming a financial success. The present canal, prior to its completion in 1790, did not attain any degree of success. Shortly after the two seas were joined, however, its traffic rapidly increased, and it became one of the most remunerative undertakings in Scotland.

Mr. James Cruickshank, in his sketch of the Incorporation of Masons (1879), referring to the canal, says: "In 1790 it was opened from sea to sea. Matters were now improving much, and shortly after the revenue was more than doubled. In 1798 it had risen to £22,000. The company's affairs improved so rapidly that they paid off their debt about 1798; and in 1799 the stock was converted into a capital of £421,525, which made the original £100 shares worth £325; and in 1800 a dividend of 10 per cent. was paid on that sum. In 1814 the dividend was 15 per cent.; in 1815, 20; and in 1816, 25 per cent.; and that year the shares sold at £500." The *Ordnance Gazetteer*, (1883), says: "In 1836 the income was £63,743, in 1839 it was £95,475, and in 1850, four years after their amalgamation, the return from the Forth and Clyde and the Monkland Canals was £115,621; while the total sum spent on the two from the beginning was £1,090,380."

PRESENT POSITION OF THE CANAL. The canal was purchased by the Caledonian Railway Company in 1867, and since that time the traffic has been largely transferred to the railway lines. It still carries a considerable amount of independent traffic, however, from which very satisfactory returns accrue to the proprietors. Mr. Clements in his paper to the Congress, already referred to, says: "It is singularly appropriate that the returns required to be made by canal and navigation companies for the first time under the Railway and Canal Traffic Act, 1888, should be forthcoming in the year which beholds the International Congress on Canals meeting for the first time in England. According to the returns made to the Board of Trade; among the railway-controlled waterways the Birmingham canal (London and North-Western) bore 7,713,047 tons, which were conveyed entirely by the proprietors, and then follows the Forth and Clyde Navigation (Caledonian Railway Company) with a tonnage of 1,257,206, none of which is conveyed by the company. The proportion of net profit per mile of navigation on the railway-owned canals is: England £99, Ireland £21,

Scotland £362. The revenue in respect of the last is nearly all derived from the Forth and Clyde Canal." The Birmingham local barge canal having carried over seven million tons; and the Forth and Clyde canal having carried over a million and a quarter tons, of independent traffic alone, in 1888, and that by means of barges, it is reasonable to expect that a waterway affording increased facilities to three-fourths of the whole shipping of the world would have a traffic of at least ten million tons, and that the proportion of net profit indicated by the returns of the barge canal for 1888 would be proportionately augmented.

PROSPECTIVE REVENUE OF THE SHIP CANAL. In view of the great increase of trade during the century, and the national and international character of the undertaking, there is every reason to believe that the ship canal would yield as satisfactory returns as the present local barge canal yielded in 1816 while under independent management.

In 1850 the present Forth and Clyde barge canal earned a revenue of £115,621, while in the same year the Clyde only earned £64,243. The Clyde last year, 1890, earned £356,202. Had the canal remained under independent management, and been extended, as the Clyde has been extended, its revenues would probably have increased in the same proportion, and it would now have been earning about £600,000 per annum. A great national ship canal in 1900 may reasonably be expected to yield a revenue five times larger than the small local barge canal in 1850. If the revenue of the Clyde Trust increases during the next ten years as it has done during the past ten years the income in 1900 will be £500,000.

Considering the numerous sources from which the revenues of the Forth and Clyde ship canal would be derived, an annual income of £600,000 could be safely anticipated. This view receives further support from an examination of the commerce of the whole country during the same period. According to the Board of Trade returns for the three years 1855-6-7, the annual average of British trade amounted to £280,000,000. For the years 1882-3-4 the returns showed that the annual average had mounted up to no less than £648,000,000—an unprecedented advance in such a short period. At the same rate of advance British trade in the year 1900 will amount to over three times the volume of 1850, say £800,000,000 per annum. The Forth and Clyde ship canal would, from its commanding position, present such advantages to this vast volume of trade that even the large revenue of £600,000 per annum seems to be small and out of proportion when compared with the prospects.

CHAPTER III.

GEOLOGICAL FEATURES OF THE ROUTE.

THE NATURAL TIDAL CHANNEL ACROSS SCOTLAND.

MR. MILNE HOME In any canal project the geological formation of the ON THE NATURAL strata to be excavated, is a consideration of vital importance. A certain route may be admirably adapted in every other respect, and fail upon this essential point. The Forth and Clyde Ship Canal project has a phenomenal advantage as regards excavation. It has been found that, at a remote period, the tides and currents of the ocean have cut their way through even the solid rock, on the route of the proposed ship canal, and that, at a later period, these tides and currents have filled up the excavation with drift deposits of sand, gravel, and clay. This important and interesting discovery was made by Mr. James Bennie, of the Geological Survey of Scotland, and the late Dr James Croll, F.R.S., who was also on that survey.

Mr. Milne Home, LL.D., F.G.S., in his work on the Estuary of the Forth and adjoining districts, viewed geologically, (1871), says: "This, probably, is the proper place for noticing the very remarkable discovery made by Mr. Bennie and Mr. Croll, of a deep trough which traverses Scotland at its narrowest and lowest part, viz., the district which connects the estuaries of the Forth and the Clyde. The discovery is one of great interest in various aspects, and chiefly in regard to the agent or agents concerned in the formation of the trough. Messrs. Bennie and Croll describe the line of the trough as running close to the canal which connects the two estuaries joining the Clyde at or near Bowling, and the Forth at or near Grangemouth." The line of the trough or channel indicated on the accompanying plan of the ship canal, Plate I., is copied from the map appended to Mr. Milne Home's work. "The trough is stated to be now filled with Pleistocene strata, viz., beds of sand, gravel, and boulder clay—the boulder clay occurring in numbers of beds, and thickness of beds, unusually great. At Grangemouth the bottom of the trough is ascertained, by borings, to be about 260 feet below the present sea level, and the depth of the trough, where its sides consist of rocks, is said to be about 118 feet. At the end next to the Firth of

Clyde the bottom of the trough is said to be about 200 feet below the sea level. At one place (near Garscadden) *the north side of the trough is actually an overhanging buried precipice*. The width of the trough can be less easily ascertained than the depth, all the borings for minerals being, of course, vertical. But at Grangemouth, where the trough passes through coal workings, the width is considered to be about 600 yards. At Kilsyth, Mr. Bennie states that the trough or 'channel (as he terms it) seems to have been split into two branches by the Barrhill, one going round it by the north, and the other by the south.' 'The south channel,' though the main one, is narrow, perhaps not more than 300 or 400 yards across, and is flanked by great hills of trap which rise over it to a height of several hundred feet, yet the channel between them maintains a depth of from 90 to 120 feet, and seems to have been cut, in part at least, out of the solid trap. With regard to the contents of the trough Mr. Bennie states that, 'at both ends' it is '*filled to a depth of several hundred feet with boulder clay, while in the middle portion, viz., from Kilsyth to Castlecary, only sand and gravel have been found.*' His explanation of the absence of boulder clay from the middle part is that 'when the land was submerged to a depth of several hundred feet, this channel (meaning the trough) existed as a *narrow kyle or strait, through which the currents and tides flowed with force, so that the boulder clay was washed out of the narrowest and highest parts, and replaced by sand or gravel.*'"

MESSRS. CROUCH The line of the proposed ship canal, described in the & **HOGG'S REPORT** accompanying report of the survey of the route by Messrs. OF THE SURVEY. Crouch & Hogg, C.E., and delineated on the accompanying plan, Plate I., follows almost exactly the natural channel indicated by Mr. Bennie and Mr. Croll. The proposals, submitted by the engineers, show that a waterway with locks of the ordinary type, and similar to those of the Manchester ship canal, can be constructed on the route; and that all the engineering difficulties can be overcome by ordinary and well-tried methods. Their proposals conclusively settle the question of the practicability of the project, from an engineering point of view. The approximate estimate of cost, made by the engineers, amounting to about £5,500,000 for works, and £1,500,000 for land and contingencies, making a total of £7,000,000, presents the only serious difficulty. Even at that figure, however, the financial success of the project can be shown to be well assured. Considering the soft and loose nature of the strata to be excavated, it is possible that the contract for the work might be undertaken for a smaller sum than the amount above stated. The cost of the works of the Manchester ship canal was estimated at £6,311,137, the total authorised capital being £9,812,000. These sums stood the test of repeated applications to Parliament for powers. After Parliamentary sanction was obtained the contract was undertaken for the sum of £5,750,000, £561,137 less than the engineers' estimate. Excavating

machines have been greatly improved recently, and contractors are now in a position to enter upon large undertakings at contract prices that would have been regarded as ruinous a few years ago.

AN ENGINEERING PROBLEM. While it is satisfactory to know that the canal can be constructed by the ordinary methods at an expenditure which, though large, would almost certainly yield a substantial and satisfactory return, it is nevertheless necessary to consider new methods of excavation by which the cost may be diminished. The ancient channel between the two firths still exists, but the passage is blocked by an enormous quantity of soft material. The tides and ocean currents that formerly accomplished the work of cutting out this ancient channel still exist. The problem, therefore, is—how to utilise the natural power of these tides and ocean currents in clearing out the deposits of sand, gravel, and clay from the bed of the channel. Mr. Milne Home says: “When this kyle existed there would be *always a strong current running through it one way or other.* What the tides were in those days, we, of course, can only conjecture. At present, when it is high water in the Firth of Clyde, it is approaching low water in the upper part of the estuary of the Forth, and, moreover, whilst the sea at high water, in the former, rises $4\frac{1}{2}$ feet above the medium level, it falls in the latter no less than 10 feet below the medium level at low water, giving, therefore, a difference of $14\frac{1}{2}$ feet between the levels of the sea at high and low water; so that *if there were to be now a free passage between the two estuaries as by clearing out this old trough, there would be a strong current running each way four times in the twenty-four hours.*”

The rise in the water of the one river above the level of the other represents a force sufficient to clear away, in a comparatively short time, the sand, gravel, and clay now obstructing the ancient channel. One method for utilising this force has been devised, and the experiments made tend to show that the deposits of soft material along the route of the proposed ship canal can be removed and carried out to deep water in the Firth of Clyde by means of the natural force generated by the rise of the tides in the Firth of Forth. Whether the method would be equally effectual on a large scale, and whether it could be carried out at a less cost than the ordinary methods proposed by the engineers, are questions that can only be decided by experts.

The new method suggested is to carry one or more large pipes by means of a tunnel along the ancient channel at low-water level, from the Forth at Grangemouth to the Clyde at Clydebank, and hence along the valley of the Clyde to deep water in the firth, or in one of the adjacent lochs. At high water in the Firth of Forth the tide would flow through the pipe with great force. Communication would be made with the pipe from the surface level of the route at necessary points by means of shafts. The work of excavation would simply consist in detaching the sand, gravel, or clay from the sides of

the shaft. The soft material falling into the pipe by its own gravity would be carried away and deposited in deep water by the force of the current. As the tides rise considerably higher in the Forth than in the Clyde, by the construction of a high-water reservoir on the banks of the Forth, a constant flow of water to the Clyde could be maintained. The experiments made also tend to show that if the flow of the water through the pipe were suddenly stopped by a movable apparatus placed at any point west of the shaft, the momentum of the current would force a certain quantity of water up the shaft to a height far above the tide level. By collecting this water in a reservoir at the highest available point, and repeating the process frequently, a practically unlimited amount of power could be obtained to aid in clearing out the ancient channel. A tidal canal could possibly be constructed by this method at a moderate cost. In such a canal, gates would, of course, be required to prevent the force of the tide injuring or interfering with the navigation. The new method of excavation, suggested, would probably be found to diminish the cost of construction of the high-level canal proposed by the engineers. This purpose served, the pipe or pipes referred to, could be utilised for discharging, into the Clyde at the Broomielaw, a great volume of pure sea-water from the Firth of Forth. The constant flow would, by sweeping the sewage out to sea, cleanse and purify the navigable way of the river, and thereby possibly solve another great engineering problem.

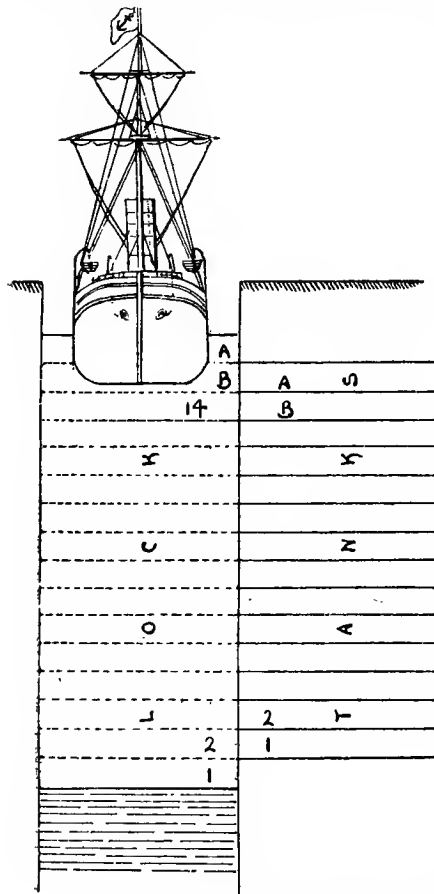
PROF. GEIKIE Professor Archibald Geikie, Director General of the
ON THE PRO- Geological Survey of Great Britain, in a letter to the
POSED CANAL. author, dated 13th May, 1889, says: "The only practicable route for a ship canal between the two firths would lie, I think, pretty much along the low ground followed by the present Forth and Clyde Canal. There is a very ancient depression through that part of Scotland, filled up with various drift deposits, so that it would probably not be difficult to select such a line as would avoid rock cuttings, and lie wholly or almost wholly in the boulder clay, and overlying gravel and sands."

NEW TYPE The immediately preceding paragraphs present the possi-
OF LOCK ; bility of a tidal canal. While such a waterway would
120 FEET LIFT. obviously possess many advantages, the height and slope of the banks would probably interfere with the development of commerce along the route. Looking, therefore, at the project from the standpoint of the establishment of industries on the banks of the canal, another proposal—among the many alternative proposals that have been submitted to the author—may be referred to. This proposal contemplates the construction of a canal at a higher level than that shown on the accompanying section, Plate II.—a level that would admit of the principal railways and roads crossing the route being carried through tunnels underneath the canal. Such a waterway, it is maintained, could be constructed at a comparatively

small cost by adopting the locks designed for the Nicaragua Canal. Plans of these locks have been submitted to the author by Mr. Lennox, C.E., of Victoria Mansions, London, with a view to their adoption on the proposed Forth and Clyde Canal. The following description of these locks is from a paper read before the Midland Institute of Engineers by Mr. G. Blake Walker, F.G.S., Vice-President of the Institute, published in the Transactions for March, 1889. Mr. Walker says: "The scheme which I will now describe to you is a *great improvement on any previous system of canal making*, and certainly far in advance of anything suggested hitherto. You will, perhaps, hardly realise, till it is explained, how very simple this plan is. It consists of a system of *making canals without excavation*, by utilising the natural boundaries of the river valleys, and by raising the level of the water. Any width and depth of water can be obtained—it is a question simply of damming up the valleys. In the case of this Nicaraguan scheme *the physical features of the country lend themselves in a remarkable way to the achievement of this design*, for which locks of a very special and ingenious kind are required." There are five locks of the following lifts—No. 1, 65 feet, No. 2, 60 feet, No. 3, 50 feet, No. 4, 120 feet, and No. 5, 55 feet. After giving details of the route, which is *about 170 miles long*, including free navigation through Lake Nicaragua and the rivers flowing from it, Mr. Walker continues: "*The estimate for the construction of this magnificent waterway is put down at £6,000,000.* Messrs. Bruce & Abernethy have made a report stating that they consider the estimate amply sufficient to complete the work. I will now point out the wonderful locks by means of which these great elevations are accomplished. I have here designs showing the construction of the lock invented by Colonel Blackman, an American engineer. The lock illustrated has a length of 750 feet between the gates, a breadth of 100 feet, and a maximum lift of 120 feet. The gates are of the sliding type of pontoons, and are wedge-shaped in form, with the broad part at the bottom, being constructed of ship's plates, supported by wrought-iron framing. They are actuated by capstans or hydraulics. By the adoption of the design for the gates, sufficient buoyancy is obtained to float the gates, and to neutralise very considerably the lateral pressure of the water. The gates are opened and closed by means of racks and pinions, actuated by a turbine, and can be opened or closed in two minutes. The system of emptying and filling the lock is most elaborate. Precautions to prevent injury to the bottoms of vessels being necessary, in the presence of such an exceptional head of water, to meet this necessity the following arrangement is adopted: two 18-foot culverts or ducts communicate with the water above the lock, and after descending to a level below the bottom of the lock, extend from end to end on either side. The admission of water to these culverts is controlled by gigantic sluice valves. The lock is crossed throughout its length by 84, or more or less, 3-foot sub-ducts or metal pipes, the upper surfaces of which are pierced with 2-inch holes, say 4 in width, and 80 in length, for each pipe,

making a total of 320 holes per pipe, or 26,880 for the whole lock. By this distribution the water is admitted into the lock without violence or possible injury to vessels. It is calculated that the lock can be filled in four minutes, although it is not intended to use such a speed. *If it is desired to economise the water used, it is proposed to do this by means of a series of tanks arranged*

in steps or terraces on the slope of the lower lock dam. Such, very shortly, is a description of the Blackman lock, by means of which it is, in the *opinion of the most competent engineers* we have—namely, Sir James Bruce and Mr. Abernethy—in this country, as well as some of the best American hydraulic engineers, possible to lift ocean-going steamers of the largest size through heights up to 120 feet vertical.”



The following excerpts are from an article by Mr. John Todd, on this project, published in the *Glasgow Herald* of 15th February, 1890. They explain the method of economising the water in the Blackman lock. The use of the diagram has been kindly granted by the editor of the *Herald*. Mr. Todd says:

“Referring to the diagram, the lock is assumed to be full of water, and a vessel about to be lowered. In these circumstances the tanks at the side of the lock are empty. When the vessel is ready to be lowered, the first or topmost tank is opened, and is immediately filled by water from the lock. The vessel is therefore lowered a depth equal to the depth of the tank. The tank is thereupon closed, the water being stored up, and the second tank is opened. It is likewise filled from the lock and closed, and the vessel is thus lowered a further distance equal to the depth of the next tank.

“For the sake of illustration, dotted lines are drawn across the lock, dividing it into spaces similar in capacity to the tanks. In actual operation, of course, no such division of the lock would exist. As shown, the water in the space A fills the tank A, and thereafter the water in the space B fills the tank B. This process is repeated until all the tanks are filled. In

course of this process, the vessel is lowered from the higher to the lower level of the canal, and is then free to pass out of the lock.

"In raising the vessel the process is simply reversed. The vessel enters at the lower level, and the water stored in tank 1 is allowed to flow into and fill space 1 of the lock, raising the vessel to that level; tank 2 is opened and fills space 2. This is repeated until the vessel is raised to the level of space 14. The two remaining spaces are then filled by the water from the canal, and the vessel is raised to the upper level. Assuming that each of the tanks in the diagram has a depth of two feet, the height through which a vessel could be raised or lowered, as shown in the diagram, would be 32 feet, with a loss of four feet of water each operation. With a lock of this kind vessels could be raised or lowered a much greater distance with about the same loss of water. As the process of raising or lowering the vessels would be rapidly carried out, the loss of water would necessarily be greater than the minimum stated. It appears to me that if this system of lock, which I have endeavoured briefly to explain, were adopted, the great objection of the elevation of the ground and the scarcity of water would be overcome."

If this system were found practicable, the works would consist principally of two locks, one near each end; a comparatively small amount of excavation; and the construction of railway and road tunnels. As in the case of the Nicaraguan Canal, "the physical features of the country lend themselves in a remarkable way to the achievement of this design." This is evident from the contour of the ground shown on Plate II. It has been estimated that by this system a thoroughly efficient waterway could be constructed at a cost of about £3,000,000. This sum appears reasonable when compared with the estimate of £6,000,000 for the vastly greater works of the Nicaraguan Canal—an estimate vouched by two of the most eminent engineers of the present time. If this estimate of £3,000,000 stands the test of a thorough investigation, then there cannot be the shadow of a doubt that the Forth and Clyde Ship Canal will, in the near future, become one of the most lucrative undertakings on a large scale that has ever been carried out in this country.

GREAT MINERAL RESOURCES OF THE DISTRICT.

SECTION OF MINERALS OF THE ROUTE.

One of the most important arguments in favour of the promotion of the project is based on the fact that the ship canal would pass through, and render easily accessible, the principal coal and mineral fields of Scotland. The accompanying vertical section, Plate III., shows the stratigraphical arrangement of the minerals found on the line of the proposed route, with the depth and thickness of the various seams. The section has been prepared, specially for this work, by Mr. John Todd, mining engineer, Kilsyth, from statistics compiled by Mr. James Duncan of Twechar, an eminent authority on the geology and mineralogy of the district. Reports on the minerals, by Mr. Duncan and Mr. Todd, are printed in the Appendix. In a letter which appeared in the *Glasgow Herald* of 28th November, 1889, Mr. Duncan says: "Consideration of the nature of the mineral field has been restricted to the north side of the present canal. A very natural jealousy has hitherto prevented the Canal

Company from giving facilities for the erection of swing bridges carrying a railway line from the south to the north side, and *vice versa*. There is only one such swing bridge, and that is at Twechar. If the new Canal Company were to purchase the rights of the old, such facilities could be given, and, by this means, an immense additional area of coal-bearing strata, lying along the south side of the present canal, would be at once added to that of the Kelvin valley. From this area there would be such a convergence of minerals towards the banks of a new ship canal as would supply the wants, not only of all sea-going steamers using the canal, but also public works and manufactories of every kind that might be erected on its banks for generations to come. Very small dues on coal shipments would yield a large revenue to the Canal Company."

SCOTLAND'S TOTAL SUPPLY OF COAL. A Royal Commission was appointed in 1866 to make investigations, and to report to Parliament, regarding the quantity of unwrought coal in Scotland. After a most exhaustive inquiry, extending over a period of five years, the Commission submitted their report to the House of Commons in 1871. From that report it appears that the total quantity of unwrought coal in Scotland, at that time, was about ten thousand million tons. Of that quantity more than one-half, including the valuable steam coal used by ocean steamers, was found to lie in the immediate vicinity of the proposed route. Of the remainder, nine-tenths was found in the adjoining districts.

TABLE SHOWING THE TOTAL QUANTITY OF UNWROUGHT COAL IN SCOTLAND.

Compiled from the Report of the Royal Commission on Coal, 1866-71.

DISTRICTS.	TOTAL OF COUNTIES. Tons.	TOTAL OF DISTRICTS. Tons.	GRAND TOTALS. Tons.
Whole of Scotland, -	-	-	9,843,465,930
Eastern District—			
Edinburghshire, -	2,153,703,360		
Fifeshire, -	1,098,402,895		
Firth of Forth, -	1,800,000,000		
Lothians, -	214,471,580	5,266,577,835	
Central District—			
Lanarkshire, -	2,044,090,216		
Stirlingshire, -	106,475,436		
Dumbartonshire, -	48,618,320	2,199,183,972	
Western District—			
Ayrshire, -	-	1,785,397,098	9,251,158,905
All other Districts of Scotland,			592,307,025

INCREASE
IN OUTPUT OF
MINERALS IN
SCOTLAND.

The astonishing increase in the output of minerals in Scotland, during recent years, affords a striking indication of the rapid advance of the commerce of the country. It proves also that greatly increased facilities for transit must soon become absolutely essential, and that such improved facilities, instead of injuring the existing means of transport, will benefit them greatly by enormously developing the volume of trade. The following figures show the sudden rise in the demand for coal alone: In 1854 the output amounted to about 7 million tons per annum; ten years later it had sprung up to 12 million tons; in 1874 the output of 16 million tons was registered; and in 1884 the large total of 21 million tons was reached. As no material increase in the population of the country took place during these thirty years, the enormous augmentation in the output must have been absorbed in additional manufactures and exportation. It cannot be maintained that the economical means of transport has increased in the same proportion during these thirty years, and, that being so, it follows that on this ground alone there must be a strong demand for greater facilities for the transport of the present augmented, and ever-increasing supply of bulky materials. The ship canal would be in the most advantageous position for benefiting this trade, and a very large revenue would undoubtedly be derived by the Canal Company from it.

A correspondent writes: "The opening of the canal would develop an enormous coal trade which cannot be estimated, but may be safely taken as an important source of revenue to the canal, and prosperity to the district, as it is fair to assume that many steamers on their way to and from Continental and Baltic ports, which now call at ports in the English Channel for their bunker coal, would take the canal route if they had the double inducement of a shorter and more sheltered voyage, combined with cheaper bunker coal, which might be supplied almost direct from the pits. It may also be fairly assumed that the opening of the canal would give an enormous impetus to the export of Fifeshire and Lanarkshire coal, and to many of the heavy manufactures of the district, as they would be in a position to command cheaper freights, either to the Continent and Baltic, or to the Atlantic, than any other port or district in the country."

Mr. Ralph Moore, H.M. Inspector of Mines, in his annual Report for 1888, to the Secretary of State, gives statistics of the output of the minerals, specified in the following table, for that year:

DISTRICTS.	COAL.	FIRE CLAY.	IRONSTONE.	OIL SHALE.	TOTAL OUTPUT IN 1888 IN TONS.
East Scotland, -	15,815,372	217,057	309,800	2,026,779	18,369,008
West Scotland, -	6,503,732	213,666	928,797	25,423	7,671,618
	22,319,104	430,723	1,238,597	2,052,202	26,040,626

It will be noted from this table that the output of coal is still maintaining the same rapid rate of increase. The trade in other minerals found along the Kelvin valley is also developing, particularly in oil shale, which is almost wholly wrought in close proximity to the east end of the proposed canal. Mr. Moore, in his report, states that the rise in the output of shale has been very rapid, as testified by the following figures: In 1875 the output was 377,108 tons per annum, five years later it had increased to 730,777 tons, and in 1888 it mounted up to the extraordinary total of 2,026,779 tons. The capital of the Limited Liability Companies working this industry in the vicinity of the proposed route is over £2,000,000, and no fewer than 10,000 men are employed in it. So far as at present known, the shale measures appear to be best developed in the counties of Linlithgow, Edinburgh, and Fife—the counties bounding the eastern entrance to the ship canal. Workable seams of shale have not yet been found in the other counties of Scotland. Notwithstanding the increased output shown by the above figures, the minerals maintained about the same price in the markets, the increase in shipbuilding, and in trade generally, having created a greater demand. As large quantities of this mineral are transported westward, it is clear that the ship canal would afford great facilities to the trade.

<p>DEVELOPMENT OF THE IRON TRADE.</p>	<p>Practically the whole of the iron trade of Scotland belongs, directly or indirectly, to Glasgow. It was founded in the city as far back as 1732, but for more than a century no very marked development took place. The great discovery made in the city in 1839 by J. B. Nelson, manager of the Glasgow Gas Works, gave an enormous impetus to the iron trade of the whole of Britain. The hot-air blast introduced by Mr. Nelson has, along with improvements since effected, been instrumental in increasing the productive power of furnaces nearly six times. The number of furnaces have also been increased during the past half century to a great extent, there being in 1888 over 70 in blast in the vicinity of the city. Large quantities of the iron raised in the district, after passing through the furnaces, are sent to the numerous ironworks in or near the city, and from hence exported in a finished state to all parts of the world. The development of this trade in Glasgow has been due to the proximity of the ironstone mines, and the consequent comparatively low charges for transport. As the chief object of the ship canal is to provide cheaper transport for heavy materials, and as it would open up new and extensive ironstone fields, with direct water communication to the city, it is evident that the project is of the utmost importance to the further development of the iron trade.</p>
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In considering the geological features of the proposed route, the question to be kept in view is whether this project for enabling coasting and ocean-trading vessels to reach the centre of the mineral districts, and save

costly and unnecessary intermediate carriage by loading directly at the mines, may reasonably be expected to advance the material prosperity of the country, and at the same time yield satisfactory returns to the promoters of the project? The more the question is studied, the more convincing becomes the evidence in favour of an answer in the affirmative. We are rapidly hastening to a period when the ever-increasing competition of foreign countries will compel us to put forth much greater efforts to maintain our commercial supremacy. In that period the great stores of coal and iron on the route of the ship canal will probably make it one of the chief centres of industry in northern Europe. If that anticipation is realised, it will be said of the deepening of the Kelvin, as Mr. Deas has said of the deepening of the Clyde, that it has "given wealth to thousands, and the means of life to hundreds of thousands of the inhabitants of the northern portion of the kingdom."

CHAPTER IV.

DEVELOPMENT OF THE LOCAL SHIPPING TRADE.

THE BIRTHPLACE OF STEAM NAVIGATION. We can only predicate of the future from the experience of the past and the signs of the present. It is, therefore, necessary, in estimating the probable success of the proposed ship canal, and its effect upon the development of commerce in the future, to review the industrial work accomplished in the district in the past, and note the signs of commercial progress in the present. After such a review it must be acknowledged that few, if any, districts in the world can claim a more brilliant record of scientific discoveries, combined with successful commercial enterprises, than the district of the proposed ship canal. A brief retrospect of a few of the discoveries and enterprises, in the shipping trade of the district, are here given, as an indication of the results that may be expected to follow the carrying out of this new shipping enterprise.

Of all the scientific discoveries that have tended to improve the material well-being of the human race, the invention of steam navigation is probably entitled to the first place. The idea that led to this great discovery was inspired by the traffic on the present Forth and Clyde Canal. William Symington, of Grangemouth, first conceived and put into successful operation

the idea of applying steam power to the propulsion of vessels. He derived his conception from the contemplation of the rapid development of local traffic and trade that followed the construction of the present canal, and the difficulties and delays of the ancient system of horse-traction navigation. Although the first trial of Symington's invention was made on the small lake at Dalswinton, the Forth and Clyde Canal gave life to the idea of steam navigation.

The world has made more rapid progress in civilisation during the last fifty years than in any preceding period. This progress is chiefly due to Symington's invention, which has established rapid communication between every country, and enabled each nation to readily obtain the benefits of the arts and culture of the others. It has also developed the world's commerce to such an enormous extent that the canal which gave it existence, then appropriately named "The Great Canal," is now dwarfed into comparative insignificance. The advance of civilisation and the development of commerce have made the construction of a greater canal, on the same route, not only practicable but essential.

SIR WILLIAM THOMSON ON SYMINGTON. Provost MacPherson, of Grangemouth, some time ago inaugurated a movement for placing a marble bust of the great inventor in the Edinburgh Museum. The memorial was unveiled by Professor Sir William Thomson on 21st November last. In the course of his address Sir William said: "*Symington was the original inventor of steam navigation.*" It was he who suggested to Patrick Miller, of Dalswinton, the idea of applying steam power to his paddle boat. "*That seemed to have been the absolute origin of steam navigation.*" The idea was carried out. "*Such a boat was got ready, and in 1789 it was propelled on the Forth and Clyde Canal.*" In 1800 Lord Dundas induced Symington to commence the building of the historical steamer, the *Charlotte Dundas*. "*That was the first practical steamship in the world. The 'Charlotte Dundas' was tried on the Forth and Clyde Canal in March, 1803, when she towed two laden sloops to Port-Dundas, Glasgow.*" To Symington, Henry Bell was indebted for his fame, "that inventor came from Glasgow frequently in 1789 to witness Symington's experiment, and in 1811 he, in conjunction with others, constructed the steamer *Comet*." Sir William in concluding said: "In Edinburgh a monument now commemorated the name of one who had done such great things for his native country, and for the whole world."

ORIGIN AND PROGRESS OF THE CLYDE SHIPPING TRADE. In tracing the development of the shipping trade of the Clyde it is necessary to go back, beyond the invention of steam navigation, to the union of Scotland with England in 1707. That event, by bringing this country into closer touch with the colonies, gave the first great impetus to the shipping trade

of the district. The merchants of Glasgow displayed their energy by at once availing themselves of this connection. They chartered vessels from ports in England to carry their merchandise to America, and bring back cargoes of tobacco. This enterprise was rewarded with such enormous success that great fortunes were made, and those engaged in the trade became known as the "Tobacco Lords." The increase of wealth enabled the traders to build vessels of their own. In 1718 the first vessel built by Glasgow capital crossed the Atlantic. The tobacco trade flourished until the outbreak of the American War in 1775. That event ruined the business.

After the collapse of the first great trade, the Glasgow merchants immediately devoted their energies to the West Indian trade, and, in a comparatively short time, the status of the deposed "Tobacco Lords" was occupied by the "West Indian Magnates." This, the second great shipping trade, maintained the prosperity of Glasgow until the discovery of steam navigation.

In the experience of the past we find the merchants of last century boldly venturing upon untried fields of international trade. Their great success tends, so far, to justify the proposed continuity of their policy in opening up new channels for the development of commerce.

When the *Comet* was launched in 1811, the total shipping of Glasgow only amounted to 2,620 tons. After that event, however, the trade increased very rapidly. In 1816 the firm of James Finlay & Company despatched the *Earl of Buckingham* to Calcutta. *This ship, the first that cleared direct from a Scottish port to India*, inaugurated the extensive East Indian trade that now engages in its service some of the largest of the steam and sailing vessels of the Clyde. In 1818 David Napier, who made the boiler of the *Comet*, and who was one of the chief founders of regular steam communication between distant parts of the world, built, and sent across the channel to Ireland, the *Rob Roy*, of 90 tons and 30 horse-power. *This was the first steamer that ever crossed a sea*. Napier, shortly afterwards, established a line of steamships between Glasgow and Liverpool. In 1840 Messrs. G. & J. Burns founded the Cunard Line by despatching to America the *Sirius*, of 2,000 tons. *This was the first steamer that ever crossed the Atlantic*. There are now steamship lines maintaining regular communication between Glasgow and Australia, New Zealand, Burmah, India, Java, Singapore, South Africa, San Francisco, Chili, Peru, Jamaica, the United States, Canada, the Mediterranean, Adriatic, and Black Seas, Italy, Spain, France, many other foreign ports, and all the important home ports.

These steamship lines are signs of the present. They indicate the rapid development of the shipping trade of the district during the last half century. From these signs we can, with some degree of certainty, predicate that commerce will develop in a similar ratio in the future. To meet the demands of that development, and provide employment for the prospective

augmentation in shipping, it is necessary to open up every channel that will enable the district to compete, with greater advantages, in home and foreign markets.

Glasgow has steamship communication with some of the ports on the North Sea, but the amount of the direct shipping trade is comparatively unimportant. The reason is to be found in the dangers and delays of the Pentland Firth. A number of steamship lines are established between ports on the Firth of Forth and the northern continental ports, chiefly for the Glasgow trade. Constant sailings are maintained from Grangemouth and Leith to Rotterdam, Amsterdam, Antwerp, Ghent, etc. These lines, and the irregular traffic indicated by the excerpts from the shipping intelligence of the *Glasgow Herald*, after quoted, show that a certain amount of trade is carried on between ports on the west of Britain and the northern continental ports in the face of serious obstacles, and point to the conclusion that, if these obstacles were removed by the opening of a channel between the Clyde and the Forth, the shipping trade of the district would greatly develop.

THE SHIPBUILD- Since the launching of the *Comet*, the Clyde has been
ING INDUSTRY OF more closely identified with the growth of steam naviga-
THE CLYDE. tion than any other river. It has thus appropriately
formed the cradle of the great conception which emanated from the valley of its tributary, the Kelvin. The genius of Symington, and the energy of Bell, have been inherited by their successors. So many improvements on the original works of these inventors have been produced on the Clyde that it has continued to maintain a pre-eminent position in the iron and steel shipbuilding trade, the marine steam-engine and boiler trade, and the numerous allied industries.

The shipbuilding record for 1890, issued on 20th December last, places the Clyde far in front of all competitors. The output from all sources in the United Kingdom in 1890 amounted to 1,271,110 tons. The year, therefore, ranks with the most prosperous in the history of British shipbuilding. To this output the Clyde contributed 349,995 tons, the Tyne taking the second position with 235,567 tons. When we contrast the present output of the Clyde with that of thirty years ago, we have a striking indication of the great strides of this local industry. The output of the Clyde for 1859 was 35,709 tons, and for 1860, 47,833 tons. The returns for most of the shipbuilding centres show a decrease on the output for 1890 as compared with the previous year. The Clyde, on the contrary, shows an increase of 14,794 tons. The *Glasgow Herald* says: "Besides taking its usual place, at the head of the shipbuilding list, the Clyde has, this year, the honour of contributing the largest quantity of shipping put into the water by any one firm in the country. This position, which was occupied in 1889 by Palmer's Company on the Tyne, is now held by Messrs. Russell, of

Greenock and Port-Glasgow, with the enormous amount of 70,370 tons." The importance of the industry is emphasised by the fact that the total number of men employed in the shipbuilding yards on the Clyde, and in the engineering works in connection therewith, is estimated at about 50,000.

The opening of the Suez Canal caused a marked development in the demand for steam vessels from the shipyards of the Clyde. The carrying out of this project would make the river, upon the banks of which these shipyards are situated, a national and international, as well as a local, waterway; it would, further, place the shipbuilders of the Clyde in direct water communication with the area in which no less than three-fourths of the shipping of the world is owned; and, by stimulating the trade of this area, it would cause an increase in the demand for new vessels. We may therefore safely predicate that the opening of the Forth and Clyde Ship Canal would, as in the case of the Suez Canal, give an impetus to this great local industry.

CHAPTER V.

ESTABLISHED INDUSTRIES OF THE DISTRICT.

EFFECT OF PROJECT UPON ESTABLISHED INDUSTRIES.

The probable effect that the proposed ship canal would have upon the established industries of the country in general, and of the district in particular, is a consideration of paramount importance. The statistics contained in other chapters tend to show that the effect of the canal upon national commerce would be highly beneficial. Nearly everyone, however, who studies the question will judge of the probable effect of the waterway from the standpoint of individual interest. The issue will, in general, be—Whether the ship canal would, by reducing the cost of transport for raw materials and finished goods, tend to increase the volume of trade and the profits of any given branch of business? If, for example, a trader in Glasgow considers that he could transport his goods to or from Dundee, Amsterdam, or elsewhere, cheaper by the ship canal than by the present routes, and thereby increase his trade and obtain larger profits, he will favour the promotion of the project. In considering this issue the project should be regarded, not as a new undertaking, but as an extension of similar undertakings in the same district, the object of the extension being to provide

increased facilities for the increase of trade created by these undertakings. The effects, therefore, of the deepening of the Clyde, and the construction of the present canal, not only upon the established industries, but also upon individual prosperity, necessarily form the basis of the judgment on this issue.

The following summaries of the principal industries now being carried on in the district are intended to indicate the possibilities of the interchange of commodities between the commercial centres referred to through the medium of the canal. The industries of the chief ports, not only of England and Ireland, but also of northern Europe and America should be included; the limits, however, of the present volume do not admit of more than a brief reference to the cities and towns within the immediate range of the influence of the proposed canal.

GLASGOW.

The number of the established industries of the second city of the empire is so great that even an enumeration of them cannot be here made. The reference will, therefore, be confined to the following succinct statements from recognised authorities. Dr. Strong says: "Glasgow unites within itself a portion of the cotton spinning and weaving manufactures of Manchester; the printed calicoes of Lancashire; the stuffs of Norwich; the shawls of France; the silk throwing of Macclesfield; the flax spinning of Ireland; the carpets of Kidderminster; the iron and engineering works of Wolverhampton and Birmingham; the pottery and glassmaking of Staffordshire and Newcastle; the shipbuilding of London; the coal trade of the Tyne and Wear; and all the handicrafts connected with, or dependent on, the full development of these. Glasgow has also its distilleries, breweries, chemical works, tan-works, dye-works, bleachfields, and paper manufactories, besides a vast number of staple and fancy handloom fabrics which may be strictly said to belong to that locality." According to the *Ordnance Gazetteer of Scotland*, "The manufactures and industries of Glasgow present a most wonderful combination. So singularly varied and extensive are they that the city combines several of the special characteristics of other cities. It has the docks and ports of Liverpool, the tall chimneys and manufactories of Manchester, with the shops of Regent Street, and the best squares of Belgravia." The *Glasgow Herald* of 29th January last, in a leader on trade, says: "It is probable that no place in the country is so well adapted for a study of industrial and economic problems as Glasgow, which combines within its area of business a great import and shipping port, a vast mining industry, valuable textile industries, and an infinite variety of other industries not often found in juxtaposition." A large number of industrial operations are carried on in various parts of Scotland, and in the north of Ireland, by means of Glasgow capital and enterprise. The varied industries of the city fit it, in an eminent degree, to form new and lucrative connections,

not only in the great business centres of the east coast of Britain, but also in the rapidly developing markets of northern Europe. To enable it to do so, however, a channel for ocean-going steamers must be cut from the city to the North Sea.

PAISLEY. The chief established industry of Paisley, viz., the manufacture of cotton, muslin, and cambric thread, together with silk and cotton shawls, has conferred upon it a world-wide reputation. In addition to the numerous cotton and thread spinning mills, there are many powerloom factories, dye-houses, bleaching and printing works, engineers' and millwrights' shops, iron and brass foundries, timber yards, distilleries, breweries, corn-flour, starch, and soap works, and large tanneries. Parliamentary powers have already been obtained for the deepening of the White Cart from Paisley to its confluence with the Clyde, three miles distant. From the accompanying plan of the ship canal, Plate I., it will be observed that the mouth of the White Cart is directly opposite the end of the proposed canal debouching into the Clyde. The deepening of the White Cart and the Kelvin valley would, therefore, practically give to Paisley many of the advantages of a North Sea port.

RENFREW. From its position at the western entrance to the proposed ship canal there can be no doubt that Renfrew would derive great commercial advantages from the carrying out of the project. Its established industries are, at present, few in number, but important in themselves. They consist of large engineering and iron-founding establishments, together with shipbuilding yards having slips for raising vessels of the largest size. There is an extensive wharf at which any of the ships frequenting the Clyde can discharge and load as expeditiously as at Glasgow.

PORT-GLASGOW. The established industries of Port-Glasgow have been gradually increasing in number and importance during recent years. The Indian and American trades have been largely developed by the excellent harbour accommodation, which affords facilities for ingress and egress to ships of the largest tonnage, at all states of the tide. A large graving dock, the first constructed in Scotland, is situated close to the harbour. Some of the shipbuilding yards are very extensive. The other trades consist chiefly of engineering works, sail and sailcloth factories, saw-mills and roperies. The ship canal would benefit Port-Glasgow by affording direct communication with the North Sea, while the national and international traffic, that would be attracted by the through route, would undoubtedly tend to develop the industries of the town.

GREENOCK. The established industries of Greenock, together with its commanding situation, would probably enable it to secure great advantages from the additional traffic that would accrue to the Clyde

by the construction of the canal. The port is already in regular steam communication with London, Liverpool, Londonderry, Belfast, Dublin, the Highlands, the Ayrshire ports, Campbeltown, the Isle of Man, and other places. It possesses a number of large harbours admitting vessels of heavy tonnage, while there is excellent anchorage outside the harbours for vessels of the largest class. The quays are very extensive, and ample dock accommodation is provided. A number of the shipbuilding yards rank next in equipment to the Government dockyards. As already stated, the output for last year of one of the Greenock firms was the largest in the United Kingdom. Most of the magnificent steamers of the Peninsular and Oriental Steamship Company were launched from these yards. Greenock has also established a large and successful trade with China and India, her vessels, from their speed and superiority, being preferred by freighters. The commerce of Greenock in general includes a number of large marine-engine works, iron foundries, very extensive sugar refineries, factories for woollen and sail cloth, large mills for spinning wool and flax, breweries, ropeworks, tanneries, and mills for papermaking.

ARDROSSAN. This port, in common with all those on the Ayrshire coast, would share in the benefits that would be derived from direct communication with the North Sea ports. Steamship lines have been established between Ardrrossan and several of the Irish ports, and there is a daily service of steamers to Arran. The shipping trade will be greatly facilitated by the new dock, which is regarded as one of the finest in Scotland. The established industries of Ardrrossan, in addition to the shipping trade, are shipbuilding and engineering, and there are extensive ironworks, sawmills, and timber yards.

AYR. The imports of Ayr, including spars and deals, linen, barley, tallow, yarn, hides, etc., show that the established industries of the town are such as would give rise to a considerable amount of direct traffic with the east, were the canal available. Excellent harbour accommodation has recently been provided, and a new dock, about eight acres in extent, constructed. Shipbuilding has become one of the recognised trades; a large shipbuilding yard having been established, where vessels of over 2,000 tons are built.

DUMBARTON. From its position there can be little doubt that Dumbarton would derive great commercial facilities from the construction of the canal. There are a number of established industries, including iron-founding, tanning, and sail-making, but the chief trade is that of shipbuilding, which is carried on in three extensive yards with great energy and success.

CLYDEBANK. This is perhaps the most flourishing district on the route of the proposed ship canal. It was erected into a burgh a few years ago. The western entrance to the canal, as designed by the engineers, would come within its bounds, and consequently the undertaking, if carried out, would increase its prosperity enormously. The district includes Yoker, Kilbowie, and Dalmuir. At Kilbowie, the works of the Singer Manufacturing Company cover about 50 acres of ground, and give employment to over 8,000 persons; while at Dalmuir the shipbuilding yard and engineering works of one firm alone cover about 30 acres, and give employment to over 4,000 men.

KIRKINTILLOCH. The ship canal would inevitably effect an enormous development upon the established industries of this town and the surrounding district. A great demand would be made upon the resources of the extensive coal and ironstone mines in the neighbourhood, for exporting and for the supply of ocean-going steamers. The importing of raw materials to, and the exporting of manufactured goods from, the various chemical and iron works would probably, by the cheapening of transport, receive a powerful impetus, and convert Kirkintilloch into one of the busiest centres of the route.

KILSYTH. Minerals, chiefly coal and ironstone, abound in the district around Kilsyth. These minerals are now wrought to a very considerable extent, large quantities being sent to the Carron Ironworks and to those in the Coatbridge district. The minerals, by supplying cheap power, and the ship canal by furnishing cheap transport, either to the Atlantic Ocean or to the North Sea, would render Kilsyth a particularly eligible site for the erection of large manufactories.

DENNY. The coal abounding in this district is also extensively wrought, large quantities being conveyed by the present canal to Glasgow and Grangemouth for exportation. Denny is particularly well adapted for the establishment of manufactories by reason of the extraordinary amount of water power afforded by the Carron. A number of industries are already erected on the banks of the river, including chemical works, and paper and dyewood mills, which, together with mining, give employment to a large population. The outlets that would be provided by this project would undoubtedly tend to develop the industrial resources of the district.

BONNYBRIDGE. A number of instances of the effect of water transport upon the development of commerce are afforded by this district. Since 1870 several works have been erected on the banks of the present canal, beginning in a comparatively small way and rapidly extending to gigantic dimensions. Among these may be mentioned the well-known

foundries for the manufacture of ornamental castings and American stoves. There are also extensive grain mills, chemical works, paper mills, and a number of brickworks. The success of these industries can be traced, to a large extent, to the cheap transport and facilities afforded by the present canal. Were the ship canal available the facilities of the respective waterways would probably be found to be in proportion to their magnitude.

FALKIRK. In view of the fact that the established industries of Falkirk are largely dependent upon the cheap transit of heavy and bulky materials, there can be no doubt that the construction of the ship canal would be of enormous advantage to the district, and particularly to the Carron Ironworks, the oldest and largest manufactory of its kind in Scotland. The ship canal, designed to pass close to the walls of this great work, would enable the largest ocean-going steamers to be loaded direct. In addition to the Carron works, there are about a dozen other large ironworks in the district. These and other industries render Falkirk the market town for about 60,000 people. There are numerous coal-mines in the vicinity, together with flour mills, extensive tanning and currying works, chemical works, timber yards, distilleries, breweries, and brick and tile works. The district is particularly noted for its three great annual cattle markets, the largest in the kingdom, known as the "Falkirk trysts." Camelon, near Falkirk, on the present Forth and Clyde canal, built, as its name indicates, on the site of an ancient Roman town, contains several extensive manufactories and foundries. The parishes of Polmont and Bothkennar, in the vicinity of Falkirk, abound in coal, ironstone, and freestone, which are extensively wrought.

GRANGEMOUTH. This town owes the development of its commerce to the construction of the present Forth and Clyde Canal. Sir Lawrence Dundas founded Grangemouth in 1777, in view of the prospective increase of trade that would accrue to it by the canal from the shipping of Glasgow and the Clyde. His expectations have probably been far more than realised in the extensive quays, wet docks, timber basins, granaries, and warehouses that now form part of the eastern port of the waterway. These works indicate the effect of a through channel in establishing trade where no trade previously existed, and in expanding industries already established. Great as has been the influence of the barge canal, in the building up of the commerce of central Scotland, it is reasonable to anticipate that the influence of the proposed ship canal, in the further development of this "vital" necessity, would be in proportion to its own capacity, as compared with the present canal; and the prospective vast increase in the trade of the twentieth century, as compared with the eighteenth century. Grangemouth, with its practically unlimited resources of coal and ironstone in the immediate vicinity, and its present and prospective facilities for transport, is probably

destined to become a place of very great importance in the future. Steamship lines are established between Grangemouth and Middlesbro', London, Hamburg, Rotterdam, Stettin, Copenhagen, etc. It possesses at present shipbuilding yards, timber yards, sawmills, sail and rope works. It imports large quantities of grain, timber, and flax from the northern continental ports, and it has in addition an extensive coasting trade. Its exports consist of minerals, and the numerous productions of Glasgow and the west of Scotland.

EDINBURGH AND LEITH.

The capital of Scotland has few established industries. In some of those which it does possess, however, it has taken a leading position. Chief among them rank the industries of publishing and printing, with the allied trades of type-founding and the making of paper machinery. The manufacture of india-rubber goods, vulcanite, water and gas meters, and iron and wire fencing are extensively carried on. The numerous breweries of the city despatch immense quantities of ale to all parts of the world. From the enthusiasm with which the project to unite the Forth and the Clyde, by means of a ship canal *via* Loch Lomond and Loch Long, was received, it is evident that Edinburgh appreciates the importance to its established industries of a deep waterway to the Atlantic Ocean.

Leith, the port of Edinburgh, is well equipped for deriving great advantages from the construction of the proposed ship canal. Its numerous docks are large and convenient, and its quayage extends to more than three and a half miles. There are many steamship companies engaged in the trade between Leith and Dundee, Aberdeen, Inverness, Wick, Orkney, Shetland, Newcastle, Hull, London, Liverpool, Hamburg, Rotterdam, etc. The principal commerce of Leith lies in its extensive home, colonial, and foreign shipping trade. It imports great quantities of grain, excisable liquors, cattle, etc., and its exports of iron, coal, and manufactured goods, are very large. Shipbuilding is carried on to a considerable extent. There are a number of very extensive flour-mills and saw-mills, together with large works for the manufacture of railway engines. Its other established industries consist chiefly of sugar refining, distilling, brewing, colour and paint making, tanning, rope, sail, canvas, and soap making, fish curing and coopering. Leith, in recent years, has greatly extended, and the marked development of its commerce has largely augmented its wealth and prosperity. Probably no port would derive greater proportionate benefit from the construction of the ship canal than that of Leith, a benefit in which the city of Edinburgh would largely share.

STIRLING.

Although this important town is off the direct route of the proposed canal, there can be no doubt that the facilities of the canal for shipping communication with the west coast would prove highly advantageous to the numerous established industries of the

town and district. These industries consist chiefly of the manufacture of tweeds, carpets, shawls, tartans, and woollen goods. Coachbuilding, iron-founding, agricultural-implement making, and tanning are also extensively carried on. River steamers conduct a considerable amount of trade with Leith.

ALLOA. An extensive shipping trade is carried on from the port of Alloa by about 100 vessels. Large quantities of minerals, woollen goods, ale, whisky, and glass bottles are exported. Alloa is particularly noted for its yarn, brewing, and distilling trades. One of the largest distilleries in the kingdom is established here. Immense quantities of grain are imported for malting. The established industries include shipbuilding, copper, brass, and iron founding, machine-making, bottle-making, and glass engraving. There are also saw-mills, dyewood works, and brick and tile manufactories. In view of the shipping and other industries of Alloa, and its convenient situation, in relation to the eastern entrance to the proposed ship canal, there is every reason to believe that the carrying out of the project would confer facilities and advantages that would tend largely to develop the trade of the town and district.

KIRKCALDY. The principal manufactories of floorcloth and linoleum, in the United Kingdom, are established in Kirkcaldy. Large quantities of these goods, together with machinery and coal, are annually exported. The cheapening of transport to the west coast, by the opening of the ship canal, would tend to develop these trades to a very large extent. Other noted industries consist of the weaving of linen, ticks, and sailcloth, and the spinning of flax and jute. Iron and brass founding and machine-making, bleaching, dyeing, china and earthenware making, and a large corn and malt trade, are carried on.

DUNDEE. The development of the commerce of Dundee has increased very rapidly in recent years. This is evident from the fact that the revenue of the harbour has risen within the last thirty years from about £2,500 to over £60,000 per annum. The increase of the shipping trade has resulted in the extension of the tidal harbour, and the construction of new quays, wet docks, and graving docks. Over £2,500,000 has been expended on the harbour, and there are now few ports in the United Kingdom with more accommodation or greater facilities for shipping. There is regular steam communication with Newcastle, Hull, London, Liverpool, New York, etc. A great cattle trade has been recently developed with America. It is obvious that the opening of the proposed waterway would afford enormously increased facilities to the commerce of Dundee, particularly from the fact that it is the great centre of the linen and jute trades. Large quantities of these goods are sent by rail to Glasgow and Liverpool for export to North and South America and Australia. Since the

introduction of the jute manufacture the progress of the district has been very rapid. There are now over a hundred spinning and weaving factories. The other established industries include the manufacture of steam engines, boilers, and various kinds of machinery and mill-fittings. Iron shipbuilding, marine engineering, and extensive saw-mills and timber yards also form prominent features in the general prosperity and industry of the district.

ABERDEEN. The most noted established industry of Aberdeen is the quarrying, polishing, and exporting of granite. This trade has now extended to enormous dimensions, and increases every year. The proposed ship canal would afford great facilities for its further development. About 60,000 tons of granite are quarried annually in the district from about twenty different quarries. About 40,000 tons are exported, immense quantities of polished stone being sent to America. Irish and West of Scotland granites are forwarded to Aberdeen to be polished and returned. The shipping trade of the city is very extensive, the customs revenue from the port amounting to over £200,000 per annum. A large part of the general shipping trade is with America. Regular steam communication is maintained with Edinburgh, Newcastle, Hull, London, Liverpool, Glasgow, etc. The established industries of the northern city embrace papermaking—the largest paper mills in Scotland being situated here—extensive cattle dealing and fish curing, cotton and jute spinning, engineering, ironfounding and agricultural-implement making, the manufacture of winceys, tweeds, carpets, woollen yarns, hosiery, etc. There are also a number of meal and flour mills, distilleries, and chemical works in the district.

CONCLUSION. From the mere naming of the leading industries of the cities and towns in the immediate vicinity of the proposed route, the judgment upon the issue stated in the first section of this chapter will probably be: That a great trade appears to await the opening of the ship canal from these industries alone; that by the reduction of freights upon the raw materials and heavy productions of the district, larger profits would accrue; and that a substantial return upon the capital expended in connection with the canal is thus assured. When we extend our view to the ports of England, the continent of Europe, and America, the possibilities of developing trade and augmenting the revenues of the canal are found to be of a wide and far-reaching character, and point to the conclusion that the undertaking would become an exceedingly remunerative investment.

CHAPTER VI.

ADVANTAGES OF SHIP CANAL TO LOCAL RAILWAYS.

RAILWAY
TRAFFIC
BETWEEN THE
CLYDE AND
THE FORTH.

The number of railway lines, and the great traffic now established between the Clyde and the Forth, afford striking illustrations of the development of local commerce during the last half century. These railway lines are signs of the present, from which the future advance of the trade of the district may be safely predicated. A comparison of the number of these lines, with those of any other district in the United Kingdom, is sufficient in itself to prove that a vast amount of through traffic now exists. The question arises: From whence is derived the traffic that maintains the eight or nine (Plate I.) practically parallel railways and branch railways between the Clyde and the Forth? The statistics furnished in other chapters show that that traffic has been, to a large extent, created by, and is now almost wholly derived from, the commerce of the waterway to Glasgow. The local railway companies owe their prosperity, one might almost say their existence, to this waterway. It has been the great feeder of the lines along its banks, and of those extending to the Forth. Waterways are frequently regarded as being antagonistic to railways; but in this case, as in many others, the waterway has been the source from which the railways have derived their revenues. The ship canal would continue and complete this waterway. It would further concentrate national and international commerce, and, while it would relieve the railways from a part of their heavy and non-remunerative transport, it would bring to them a great increase of the lighter remunerative traffic requiring rapid despatch from the wharves along its banks.

Interesting evidence on these points is afforded by the address of the Marquis of Tweeddale, Chairman of the North British Railway Company, to the last half-yearly meeting of the shareholders of the company, reported in the *Scotsman* of 1st October last. The Marquis said: "As regards capital, we estimated the expenditure of £330,000, and we have exceeded that estimate by nearly £70,000. This excess is in part due to extra works, and in part to the *necessity for additional waggon stock*, without which it would be impossible efficiently to conduct *our ever-increasing traffic*; indeed, we have found it necessary to propose in the current half year to expend for plant a further sum of about £100,000. Altogether, we propose to expend in this half year a sum of about £300,000.

We should be glad to be able to keep our expenditure within narrower limits, but the *continued demands upon us for increased accommodation, taken with improving traffic*, render such a course impossible. Turning to the revenue account, you will observe that, as compared with the corresponding period, we have carried upwards of 23,000 additional first-class passengers. The increase of numbers in the third-class amounts to nearly 2,000,000, as compared with a year ago. Our goods traffic is better by about £33,000, but to earn that we have had to carry 74,000 tons more than we did twelve months since. The live stock traffic is some £3,000 better, and the mineral traffic about £35,000, to earn which we have had to carry nearly 400,000 tons additional. These are the figures as they appear in the revenue account, and they would show an increase in receipts from all sources of £134,000. It is obvious, of course, that we cannot carry about two millions of additional passengers, and transport about 450,000 tons of additional goods and minerals at the same cost as if the traffic had remained stationary." Figures are given showing the additional expenditure, for this increased traffic, on locomotive power, repairs to rolling stock, traffic charges, etc. "*The result of the whole of the increased receipts and increased expenditure amounts to this—that there is less available for dividend by £4,000, and more is required for dividend than before.*" The dividend of $1\frac{3}{4}$ per cent. which we recommend is necessarily not a little disappointing. At the same time, it must be remembered that our position differs in no respect from that of other companies, whose accounts show that the whole of their additional receipts have failed to yield any additional profit. I would like to say that, while we naturally anticipated a considerable increase of traffic on the opening of the Forth Bridge, we did not expect that it would have developed so rapidly, and to such a remarkable extent as has proved to be the case. As evidence of this, I may mention that the traffic between Edinburgh and Dunfermline and Kirkcaldy has increased, in these very few months, no less than 88 per cent. The through traffic has increased very largely, and probably the increase would have been still larger, if our accommodation in Edinburgh station had been equal to the demands made upon it. I have referred to the increase of traffic due to the opening of the Forth Bridge, and I am very glad to be able to add that it is already earning almost enough to pay the full dividend on its cost, so that no fear need be entertained that either we or any of the guaranteeing companies will be called upon to make up any deficiency under our guarantee."

The salient points of the address, in its relation to this project, may be briefly referred to: (1) There would be practically no additional expenditure required to meet the increased traffic on the ship canal, as no equivalent to rolling stock would be maintained. (2) The "ever-increasing traffic" of this company appears to require an additional expenditure of no less than

£700,000 per annum. This shows that there is ample room in the district for other channels of trade. (3) The additional 74,000 tons of goods carried—that is, the lighter remunerative traffic referred to—earned £33,000, equivalent to about 9s. per ton; while the additional 400,000 tons of minerals—that is, the heavy non-remunerative traffic—only earned £35,000, equivalent to about 2s. per ton. The object of this project is to relieve the railways, to some extent, from the burden of their mineral and other non-remunerative traffic, and to bring to them in return a great increase of remunerative goods traffic. (4) The statement that, notwithstanding the great increase of traffic, not only on the North British but on all the other railways, the “additional receipts have failed to yield any additional profit,” clearly shows that there is a ruinous element permeating the whole of the railway system of the country—an element which, unless it is removed, will continue to reduce the dividends of the shareholders, retard the development of commerce, and inevitably end in disaster. The root of the disease lies in the carriage of heavy, non-remunerative traffic. (5) The very remarkable statement that the Forth Bridge is already earning almost enough to pay a full dividend on its cost of over £3,000,000, furnishes several strong arguments in favour of this project. It shows the extraordinary volume of local traffic, and demonstrates that additional facilities for transport in the district speedily create trade. If this local bridge, a few months after its opening, yields a revenue at the rate of £150,000 per annum, it is reasonable to anticipate that the proposed ship canal, with its national and international, as well as its local advantages, would yield at least four or five times more than one of the bridges over its route.

MAINTENANCE OF CANALS AND RAILWAYS. The power of the ship canal to transport a great additional traffic without materially increasing expenditure is a highly important element in the project. Every ton of merchandise carried on a railway depreciates the permanent way and rolling stock, and increases the cost of upkeep; in other words, the working expenses of a railway rise or fall with the increase, or diminution, of the volume of traffic. Increase of weight does not affect the waterway, and as ship canal proprietors are toll-takers, not carriers, there is nothing equivalent to the depreciation of rolling stock. The returns of the Suez Canal show that the annual expenses of maintenance were higher during the period from 1871 to 1876, than from 1876 to 1881, notwithstanding that the traffic had more than doubled during the latter period. The cost fell from 0·35d. per ton per mile, to 0·134d.; and in 1882-3 it was further reduced to 0·088d. The cost of maintenance on a ship canal between the Clyde and the Forth, particularly on a tidal canal, would be very low as compared with the railways along the same route. Rates would be correspondingly low, provided the cost of construction were kept within moderate limits. Low rates would attract an enormous amount of traffic, to the benefit, not only of the trade of the

district, but also of the railway and canal companies. It is the province of the ship canal, on the one hand, to focus traffic from all parts of the world to a limited area, as in the case of the Clyde; and it is the province of the railways, on the other hand, to take up the traffic on the borders of that limited area, and distribute it to all parts of the country. The two modes of transport are essentially distinct and mutually beneficial, and, that being so, the local railway companies ought to welcome the project as a means whereby they may increase their remunerative, and decrease their non-remunerative traffic.

EVIDENCE OF
EXPERTS ON
CANALS AND
RAILWAYS.

The country or district that cannot, owing to engineering difficulties, or does not, owing to lack of enterprise, make adequate provision for the cheap transport of heavy materials, in addition to providing an efficient system of railway transport for light and costly merchandise, will, almost inevitably, be left far behind in the keen commercial race now engaged in between different countries, and different districts of the same country. Railway monopolies and excessive charges for transport retard progress and diminish trade. The railway companies themselves are among the first to feel the effects of injury to trade, and it is, therefore, the interest of such companies to support any project that will tend to maintain and develop local, national, and international trade. This view is borne out by the following authorities:

General Rundall, R.E., C.S.I., in his address at the Conference on Canals and Inland Navigations (1888), said: "Now that that stage in our history has been reached when the question is not merely whether our ancient commercial supremacy is seriously threatened, but, rather, whether its very existence is not imperilled, *it becomes an absolute necessity to guard against our being left behind in the race.* It behoves us, then, to take care that we do not miss the lesson that is being taught us by those continental nations who are *fast wresting from our manufacturing and commercial classes not only the position, wealth, and importance inherited from our forefathers, but absolutely, in many industries, their very means of existence.* So long, then, as our continental neighbours shut their eyes to the benefits of reciprocity in fiscal arrangements, the only opening in which there seems to be a possibility of, at all events, diminishing the odds against ourselves, is to *endeavour to reduce the cost of transport, both of the raw material and of the finished product.*"

Mr. F. R. Conder, M.Inst.C.E., in his paper to the same Conference, says: "The canals were ruined by the abstraction of their natural traffic. But the theft was twice cursed; it ruined those who took as well as those who lost. *Railway proprietors were slow to perceive, many of them have not at this moment perceived, that the vast sums which they were annually called upon to spend on the improvement of their property did, indeed, extend it, but did*

not improve it in the way of net earning. In 1844 the passenger traffic of the railways yielded 60 per cent. of the gross revenue, the remainder being earned by goods traffic, and the net profit was 10 per cent. on the capital. In 1885 the passenger traffic yielded only 43 per cent. of the gross revenue, 22 per cent. was derived from a very low-rated mineral traffic, the working expenses rose to 53 per cent. of the revenue, while the profit on the capital only amounted to 4 per cent. It is the transport of minerals and heavy goods at non-remunerative rates that chiefly reduces the dividends of the railway companies, and it is these same rates which, though non-remunerative, are nevertheless, too high to enable the manufacturer to compete in many cases against foreign competitors. Neither the manufacturers nor the railway managers had the gift of prescience. The first did not anticipate a close contest with the foreigner in the art of production, the second did not understand the law that limits the capacity of their lines for transport. For those who wish to skip the figures it may be enough to say that the discontinuance of a given quantity of slow traffic, earning 10 per cent. over working expenses, would make room for the conduct of a very much larger quantity of quick traffic earning over 50 per cent. of profit. Rightly considered, the interests of the carrier, on the one hand, and of the freighter on the other, are constituent elements of the nation's welfare. It is a loss—it may prove a fatal loss to the nation to deny to our inland towns facilities for the cheaper mode of transport, that is to say, for water transport. It is a loss to the owners of railways to carry heavy goods at less than three times the cost of carriage by canal. The impoverishment and ruin of the manufacturer would be a national disaster. It is mere loss of time to inquire which of these evils is the greater. The part of wisdom is to avoid them all. This is now possible. It may be and be too late. To neglect the true solution of this vital question is little short of national suicide."

Mr. M. B. Cotsworth, C.E., in his paper to the same Conference, says: "Now comes the question—What is best to be done? It is clear that, *owing to the neglect of our inland navigations, a very considerable trade has been secured from us by continental nations* who have long recognised the value of inland navigation in its relation to commerce. The consequence is, many of our manufactures are languishing, whereas they might have been flourishing now, if inland navigation had received the attention it deserves. We may instance the coal, iron, and cement trades. Iron is conveyed on the Belgian canals at a cost of 2s. 6d. per ton, the same distance as that for which 12s. 6d. per ton is charged by railway in England. This advantage, together with the low sea freight, *enables the Belgian ironmasters to compete with success for the English iron trade*, consequently, we really employ large numbers of men in Belgian foundries, etc., instead of at home. It is just the same with the plaster, cement, and other heavy trades. Immense quantities of this traffic are sent by water from Paris and other continental districts, at

a cost of 5s. per ton, or under, to London; whereas we have millions of tons, in the mines of the Midland district, unworked, because the rail carriage to London, of 7s. 6d. per ton, prevents the Midland manufacturers from competing with success. From these, and other considerations, we may fairly say that *the canal question is becoming one of national importance, and demands our most serious attention.* The foremost consideration should be to effectively provide, not only for the existing trade, *but also for an immensely increased traffic* which is sure to follow if inland navigation is placed on a thoroughly effective footing as regards the cost of transit. *When rates are very low 'thousands of things are then discovered to be worth moving which nobody thought of before.'* We may take it for certain that England, with her unbounded mineral resources, vast manufactures, coupled with her imperial power and wealth, *will require such immense facilities of transport as inland navigation alone can supply.* The above advantage, whilst affording unbounded relief to commerce and the public, would result in increased employment for the labouring classes, and add to the wealth of the nation by creating *a revival and permanent expansion of trade, thus relieving our present burdens, without imposing new ones."*

Sir Douglas Galton, R.E., K.C.B., F.R.S., in his opening address to the members of the same Conference, said: "The cost of carriage is so important an element in cost of production and in profit, that the question may very usefully be raised as to how our waterways can be best regulated, so as to afford the relief so much required by our national industries under the new conditions of competition, to which they are exposed from the increased production of foreign countries, and the very low rates at which these foreign products are delivered in this country. Sir Michael Hicks-Beach and Mr. Gladstone, in a recent debate, whilst repudiating the idea of the State purchase of railways, threw out the idea that *the State might purchase the canals, mainly, apparently, on the ground of their conditions of traffic approximating rather to those on a turnpike road than to the conditions of railway traffic.* The State purchase of canals would, no doubt, be a much simpler operation than the purchase of the railways, and it is quite possible that *some scheme for their maintenance and management might be devised under the new County Councils."*

Mr. J. Stephen Jeans, M.R.I., F.S.S., in his recent exhaustive work on "Waterways," says: "The country had for many years been enjoying an exceptional amount of prosperity. The start that our mechanical and manufacturing superiority had given us, in the race of nations, aided and abetted by the locomotive engine and the steamship, and the awakening of foreign countries to a sense of requirements previously ungratified, if not unfelt, created an enormous demand for our industrial products. *In many industries, indeed, we had hardly any competition.* In most others there was a sufficient margin of profit to make it of little consequence what rates

were charged for railway transport so long as the transport was effected. In such a race as this the slow movements of canal boats were not deemed worthy of attention, and the railways had it all their own way. *But a time was now at hand when all this was about to be changed.* Foreign nations had learned our arts and manufactures; had adopted our processes; had purchased our machinery; and had instituted systems of technical instruction that caused industrial knowledge to be generally diffused and thoroughly appreciated. The development of the modern steamship, acting in concert with the improvement of railway transport in the United States, inflicted upon British agriculture a blow from which it has not rallied, and possibly never may. Almost suddenly a very remarkable fall took place in the profits of agriculturists at home. Our agricultural population, with its purchasing power thus seriously crippled, did not bring orders into the manufacturing districts to the same extent as formerly. Co-incidentally with this falling off in the home demand, foreign nations, having learned to supply their own wants, sought fewer English-made goods than before. *A little later still, and they were competing 'brow to brow' with English industries in neutral markets.* Our import and export returns, which had been advancing with protentious strides, suddenly dropped down in a way that caused serious alarm. It was found that *the decline was one of price rather than of volume*, and manufacturers, having to accept much less profits than formerly, were compelled to strain every nerve to make ends meet. This could only be done in one or other of three different ways—by the command of cheaper materials; by more economical processes of manufacture; or by cheaper transport. The railways of the United States, the telegraph system, and our own steamship lines, provided the first desideratum. The second were diligently looked after by the manufacturers themselves. As regards the third they were powerless. Inquiry revealed the fact that *the railway rates charged in England were generally higher than those charged in competing countries.* In some cases they had damaged once flourishing industries, and imperilled the very existence of large centres of population. Complaints against railway monopoly and railway exactions became universal. The railways were for a long time inexorable, and as they turned a deaf ear to the remonstrances of traders, the latter had to seek elsewhere for relief.

“At this stage in the remarkable annals of recent industrial progress, attention was once again turned to the comparative merits of canals and railways for the transport of heavy traffic. A Committee of the House of Commons was, in 1882, appointed to inquire into the subject of British canals. This committee sat for a considerable time, and took a great deal of evidence, most of it of an extremely unsatisfactory character, as showing how greatly British canals had passed under the domination of the principal railway companies. *The report of this Committee directed renewed attention*

to the advantages of canals as a means of transport and gave an impetus to canal construction, of which the Manchester Ship Canal, now approaching completion, is the latest and most signal triumph."

**ADVANTAGES OF
CANALS TO
RAILWAYS IN
FRANCE.**

From the foregoing evidence we are forced to the conclusion that Britain, by neglecting inland waterways, has diminished her industrial power and retarded the development of her commerce, while the railway companies have wasted vast sums of money on non-remunerative plant, and very seriously diminished their profits. Continental nations early perceived the danger of throwing both the remunerative and non-remunerative traffic upon railways. France, Germany, Belgium, Holland, and other countries, while benefiting by the science and experience of Britain in the development of railways, have carefully improved their canals, and maintained the important element of economy of transport, in addition to their long hours of work and low wages. Foreign countries have thus availed themselves of various advantages neglected by Britain, and they have thereby gained a footing in British markets. France long ago noted the true positions of canals and railways, and an enlightened policy has, in this respect, been pursued. In 1833 an inquiry was instituted, and M. de Berigny reported to the Chamber of Deputies that "each of these two ways of communication has its distinct and special domain." M. Picard, President of the Public Works section of the State Council, in his Treatise on Railways (1884), referring to M. de Berigny's report, says: "Nothing is, to-day, more true. Almost everywhere that navigable routes and railways run side by side, the development of industry and commerce has been such that, after a brief crisis, the traffic of the older line of communication has notably increased. *Far from being enemies, railways and canals aid one another in the performance of their natural duties. The former transport passengers, costly merchandise, manufactured products, all that cannot endure long delay; the latter, on the other hand, transport raw materials of small value, for the transport of which speed is of secondary importance, which cannot bear high rates of charge, and which in consequence do not form a remunerative traffic for railways.* The Canal Marne au Rhin placed side by side with the railway from Paris to Strasburg, affords veritably prodigious assistance to the mineral, salt, and sidereal industries of Lorraine; 83 per cent. of its traffic is contributed by the neighbouring industries created subsequently to its formation. *The ores which lay dormant under the ground for centuries have been dug up from their secular slumber, the mills are as though sprung from the earth, collected against each other between the canal which brings them the raw material, and the railway which transports their produces. A continuation of mines, ironworks, furnaces, salthworks, and quarries following on each other without interruption in the suburbs of Nancy. There has been, as elsewhere, a radical transformation in the appearance of the country, an*

increase of activity, and consequently of wealth, *in which France largely shares, of which the Treasury itself reaps the advantage in a thousand different ways*, and which should fully compensate for the first cost of construction and maintenance."

From the commanding position which the Forth and Clyde Ship Canal would occupy, the author is convinced that the words used by M. Picard in describing the results produced by the construction of the Marne au Rhin Canal, will, in the future, *be equally applicable in describing the increase of local activity and wealth, and the benefits to the railway companies and the State*, produced by the carrying of this project into execution.

NATIONAL ASPECTS OF THE PROJECT.

CHAPTER VII.

MAINTENANCE OF NATIONAL COMMERCE.

THE PRESIDENT OF THE BOARD OF TRADE ON CANALS. The Right Hon. Sir Michael Hicks-Beach, President of the International Congress on Inland Navigation, in his opening address to the members of the Congress, delivered on the 28th July, 1890, said :

"During the last few years, unquestionably, *the public interest* has been excited in this matter of inland navigation very differently to the way in which it was regarded for some little time before that. That excitement, as it were, came to a head in the great movement which, in this particular district, gave life and commencement to the Manchester Ship Canal. The Manchester Ship Canal is due to individual enterprise. That it will do great good to this part of England, I believe, and earnestly hope. But in doing good to this part of England, if it be successful, my belief is that *it will inaugurate for the rest of the country almost a commercial revolution*. What seems to me to be novel and full of promise, for the future of the Manchester Ship Canal, is this, that it is not merely a canal between two seas, or a canal only connecting one great city with the sea; *it is a canal which through its whole length of 35 miles may be one great dock*. If that be so, if factories and workshops arise along the length of that canal, if it becomes, as I have said, but one great dock for this great manufacturing district, *we may be quite certain that the example of the Manchester Ship Canal will be imitated in other similar districts in other parts of Great Britain*. We may be certain also that, if that is done, subsidiary navigations which may feed these docks will be amalgamated and deepened and extended, that locks will be rebuilt and enlarged, that all kinds of improvements will be made con-

necting smaller places with those great arteries of the sea, and that in this way, *now that our manufacturers and merchants are so heavily handicapped in a competitive race by other nations in the world's markets, the inestimable advantage of a cheaper outlet may be afforded to them to deal with their customers in all parts of the world.* I think I am right at any rate in this; it may be a dream, but if it be a dream, it is a dream of a prosperous futuro which may come from the development of our inland navigation, which has not been so much as thought of for the last two generations. Of this I am quite sure—that when you bring your judgment and experience and practical knowledge to bear upon them, the results of your deliberations cannot be but of the greatest value to the whole brotherhood of nations. I have only to add my sincere wish that this Congress may result in permanent benefit to the intercourse between nations, and consequently to the peace and happiness of the world."

His Royal Highness the Prince of Wales, patron of the Congress, telegraphed:

"My hearty congratulations on the opening of the International Congress on Inland Navigation. I sincerely trust that the deliberations of its members may lead to practical and beneficial results.—ALBERT EDWARD."

RECENT
DEVELOPMENT
OF NATIONAL
COMMERCE.

The development of British trade during the last thirty years has been so unprecedentedly rapid that the construction of a ship canal across the island is now not only practicable but necessary. Mulhall in his "History of Prices," says: "There has been a steady uninterrupted increase of trade since 1854"; and again, "The trade of the United Kingdom has risen £140,000,000 sterling since 1870, *an increase unequalled in any other country in the world.*" The rapid advance is shown by a table, from which the following extracts are made: In the three years, 1855-6-7, the annual average of British trade, according to the Board of Trade returns, amounted to £280,000,000. Ten years later the average had mounted up to £450,000,000. In 1870-1-2 the returns showed £556,000,000, and in 1882-3-4 the total average of £648,000,000 per annum was reached. From its situation the Forth and Clyde Ship Canal would be of direct advantage to a large part of this vast trade, and would further augment it by opening up new connections and fresh fields for enterprise both at home and abroad. A few of the directions in which the national commerce of the country would probably be augmented, and from which a very large revenue would be derived, may here be indicated as follows:

1. Regular liners from Glasgow to Newcastle, Hull, London, etc.
2. Regular liners from Leith, Dundee, Newcastle, and Middlesbro' to Atlantic ports.
3. Regular liners from Liverpool to northern continental ports.
4. Jute ships from Dundee to Liverpool, in ballast, to load salt, outwards.
5. Grain ships from Atlantic ports to Leith, Newcastle, etc.
6. Timber ships from Baltic to the Clyde and Irish ports.
7. Coal ships from the Tyne to Dublin and other Irish ports.

8. Iron cargoes from Middlesbro' to Glasgow, Greenock, and north of Ireland.

9. Limestone cargoes from north of Ireland to east coast ports.

10. Salt from Liverpool to east coast fishing stations.

Many other sources of traffic will occur to traders conversant with particular branches of the shipping trade.

EFFECTS OF
INCREASED
TRADE ON
INDIVIDUALS.

The statement that trade has developed from £280,000,000 to £648,000,000, in a comparatively short period, conveys but a vague conception of the influence of the increase of trade upon the general well-being of the community.

The beneficial influence of the increase can be more readily comprehended by noting the average effect upon individuals. Mulhall says: "Each inhabitant of the United Kingdom possesses, on an average, 70 per cent. more income than in 1850, as appears from the assessments of income-tax, which are further confirmed by the legacy returns. The valuation of house rental is perhaps more conclusive than the other two, as the wealth of a people is directly in ratio with the character of their dwellings. Each inhabitant pays now more than double the house rent that he paid in 1850, and if we go back no further than 1870 there is an improvement of 36 per cent. in these fourteen years, not from any artificial rise in value, but from the large amount of capital that has gone into building since 1870. The consumption of food is the best of all measures of a nation's prosperity, and, in this respect, each year sees an improvement in the United Kingdom. In 1850 the consumption per inhabitant ranged as follows: Sugar, 25 lb.; meat, 76 lb.; wheat, 290 lb.; and tea, 29 oz. In 1884 the consumption had increased as follows: Sugar, 72 lb.; meat, 105 lb.; wheat, 340 lb.; and tea, 78 oz. Again, in 1850 there were 30 millions of deposits in the savings banks, equivalent to a deposit of 21 shillings per inhabitant, while in 1884 the deposits had increased to 90 millions, showing a sum equal to 50 shillings per inhabitant." Mr. Mulhall concludes: "From the foregoing facts we have undoubted proof *that the commerce of the United Kingdom has been, and continues to be, prosperous; that it is closely connected with the public fortune; and that the condition of the masses is improving.*" These statistics form an incentive towards the prosecution of a project which must necessarily develop the national trade, and add to the sum of human well-being by placing within the reach of all classes increased facilities for commercial enterprise.

EFFECT OF
WATERWAYS
ON COMMERCE.

Those nations that possess the most elaborate and economical means for the transportation of commodities by land and water, are invariably the most prosperous. However great the natural advantages and the productive power of a country may be, unless its raw material and manufactured products can

be conveyed speedily and cheaply from the places where they are produced to the markets where they are in demand, the inhabitants of that country neither obtain the use nor enjoy the benefits of the natural wealth that surrounds them. To convert that natural wealth into its equivalent in money, a complete and economical system of land and water conveyance must first be instituted. Inland waterways for the cheap transport of heavy merchandise of small value; and railways for the speedy transport of light merchandise of greater value, are absolutely essential to national prosperity.

Mr. J. W. Harvey, in his pamphlet on the Manchester Ship Canal, says: "The carrying out of improvements which increase the facilities for cheap transit, cannot fail to stimulate mining, manufactures, and agriculture. The effects of transit charges in their incidence are precisely the same as those produced by the operation of hostile customs tariffs. It is of no consequence to the consumer what elements make up the price of the commodity he requires. If he finds the price too high, what does it matter whether the article is made dear by a protective tariff, or by the too great cost of transport? *Reduce transport charges, and you extend your operations to markets previously closed against you.* To the manufacturing interests of the country generally this question of the cost of transit is of the first importance." By reducing transport charges on heavy materials, and thereby creating new markets and opening others now closed, the ship canal would enable the country to reap much greater benefits from its natural advantages and productive power.

MR. JEANS
ON CHEAP
TRANSPORT.

Mr. J. Stephen Jeans, whose work on "Waterways" has been already quoted, Member I.C.I.N., in his paper to the Congress, says: "Next to adequate and inexpensive supplies of food and clothing, the most essential element in the well-being of a nation is undoubtedly cheap and sufficient facilities of transportation. It is, perhaps, not too much to say that without the latter the former could not exist. Unless the railways of the United States, and the rivers and canals of Central India, and the railways and waterways of Russia, had co-incidentally existed and laboured in order to place cheap wheat supplies at the disposal of the people of this country, those supplies would not have been available, and, *in such a case, the material condition of the inhabitants of these islands would, in all probability, have been much worse than it is.* Unless Australian wool, American cotton, and the materials furnished in lesser degree by other countries, had been available, the masses of our population could not have been so comfortably clothed as they now are. And so with other essentials of material welfare and prosperity. *Nations may even be able largely to dispense with a fertile soil and productive mines if they are in a position to command cheap and*

adequate transport; but no nation, however fertile its soil, or however valuable its mineral resources, can afford to dispense with the third indispensable element in material well-being. These things being so, *it becomes one of the most urgent questions that can engage the attention of this*" (the International Congress on Inland Navigation) "*or any other deliberative assembly, how the means of communication can be most cheaply and advantageously obtained. This is, indeed, the most important problem that we could possibly undertake to consider*; for if we can settle it satisfactorily, and apply the knowledge so obtained to the fullest extent, *our future may be regarded as well assured.*" Mr. Jeans, as an authority upon this question, places cheap transport next to food and clothing as an absolute necessity. He shows that the latter necessities are dependent upon the former. It is, therefore, as incumbent upon each district to provide adequate means of transport as it is upon each individual to provide a sufficiency of food and clothing. Failure to provide these natural and essential requisites, in both cases, results in decay. Mr. Jeans, in effect, proves that every individual in the district has a direct and personal interest in the furtherance of this project to provide "the third indispensable element in material well-being."

SUMMARY OF
THE NATIONAL
ADVANTAGES OF
THE PROJECT.

It has been shown that the commerce of the country has developed enormously in recent years, and that that development has had a highly beneficent influence upon the material well-being of the community. It is now necessary to show more particularly the facilities that the proposed ship canal would provide for the maintenance and continued development of this commerce. In doing so, the natural advantages that have hitherto mainly contributed to develop British trade must be kept in view. The chief of these advantages are as follows:

I. The sea channels and extensive coast-line have impelled Britain to provide a mercantile fleet that has made her the greatest trading nation.

II. The numerous navigable rivers have fostered the trade of the interior, and forced her to construct many harbours for the accommodation of that trade; and

III. The vast mineral resources have enabled her to become the greatest producer of commodities.

The Forth and Clyde Ship Canal would combine in itself all these essential elements in the production of national wealth. Its chief national advantages may be briefly summed up thus:

1. It would add another sea channel, and practically extend the coast-line through one of the principal industrial centres of the country.

2. It would unite at the most suitable point the two seas most frequented by national commerce.

3. It would enable mariners to avoid the dangers to life and property of the north and south passages.

4. It would benefit the coasting trade by reducing, to the extent of hundreds of miles, the distance between nearly all the great shipping ports on the east and west coasts.

5. It would render two of the largest navigable rivers of the island national, as well as local, highways of trade, and greatly increase their value.

6. It would provide the best and most extensive harbour accommodation on important trade routes.

7. It would be of inestimable service in the maintenance and protection of national trade in the event of war.

8. It would necessitate the building of more ships to meet the demands of the increased national trade.

9. It would open up one of the largest mineral fields of the country, and enable coasting and ocean-going steamers to coal directly at the source of supply.

10. It would benefit the carrying trade of the interior by relieving the railways from the burden of their heavy, non-remunerative traffic, and by bringing to them from all quarters a large accession of lighter profitable traffic.

A project capable of conferring such benefits on commerce must necessarily, if carried out, redound to the prosperity of the nation, and, at the same time, have its own financial success fully assured.

Mr. C. J. Wilson, of Deanfield, Hawick, manufacturer, in his letter to the *Economist* of 9th of December, 1889, says: "The nature of the route would also be completely changed from the tempestuous, dangerous, and uncertain navigation of the Hebrides, Pentland Firth, and stormy north of Scotland, to an inland channel absolutely free from danger, both in times of peace or war, decreasing the wear and tear upon the vessels, and materially lowering the rate of insurance. The great Suez Canal, the ship canal at Amsterdam, and the St. Petersburg Canal, are instances in which ship waterways have proved of great advantage in their respective countries, and the ease with which the immense capital required for the Manchester Ship Canal was raised, was a proof of the great advantage which Manchester and Lancashire expect to derive from the cheapening of communication. The Forth and Clyde Canal would undoubtedly have this effect; connecting the two most frequented seas of the world, it would be hailed as a benefit to the commerce of Britain and northern Europe, and a valuable addition to our national defence."

CHAPTER VIII.

DANGERS TO NATIONAL COMMERCE.

THE PASSAGE OF THE PENTLAND FIRTH. The whole passage by sea round the north coast of Scotland may be described as a dangerous one. At various points the perils which mariners have to face become greater than those met with in almost any other part of the world. The narrow channels, and rapid, turbulent tidal currents; the frequent storms and fogs; the proximity of the chart routes to the rocky coasts; the want of harbours of refuge, and the large number of vessels frequenting these waters, all contribute to render the passage unusually hazardous to life and property. "Nowhere else round the British Islands," says Professor Archibald Geikie, "can such a sea as that which rushes and roars through the Pentland Firth be witnessed. It seems like a vast river, but with a flow some three times swifter than our most rapid rivers. Such a broad breast of rolling, eddying, foaming water. Even when there is no wind the tide ebbs and flows in this way, pouring, now eastwards, now westwards, as the tidal wave rises and falls. When the tide is coming up against the wind, the water no longer looks like the eddying current of a mighty river. It rather resembles the surging of rocky rapids. Its surface is one vast sheet of foam and green yeasty waves. Every now and then a huge billow rears itself impatiently above the rest, tossing its sheets of spray in the face of the wind, which scatters them back into the boiling flood. Here and there, owing to the configuration of the bottom, this turmoil waxes so furious that a constant dance of towering breakers is kept up. Solid sheets of water rush up the face of the cliffs for more than 100 feet, and pour over the top in great volumes."

According to the *Ordnance Gazetteer* the length of the firth is about 14 miles and its breadth about 7 miles. At the eastern entrance a number of islands lie right in the centre of the passage, causing ships to make a detour at a point where approach to either shore is dangerous from the strength of the current. Ships have to wait at either end till the set of the tidal current, which runs at the rate of from 6 to 12 miles an hour, is in the direction in which they wish to pass, as it is utterly useless to attempt to push on against the flow. In consequence of sudden contractions and expansions of the channel, and of the intervention or obstruction of headlands, islands, rocks, and shoals, counter-currents are produced in the firth as rapid as the tide itself, and these, in their collision with one another, or with the tide, or sunken rocks, produce powerful eddies and stupendous

spoutings which, when lashed and infuriated by gales, are menacing to even the largest vessels. Great as the danger is in a gale, it is even more imminent during a calm, and more particularly if the weather is foggy, for ships drift along while the crew believe them to be stationary, with the consequent risk of stranding and collision.

CAPE WRATH AND THE MINCH. Of Cape Wrath, Sir Walter Scott wrote: "This dread cape, so fatal to mariners, is a high promontory whose steep sides go sheer down to the breakers which lash its feet. There is no landing, except in a small creek about a mile and a half to the eastwards. There the sea plays at long bowls with a huge collection of large stones, some of them a ton in weight, but which these fearful billows chuck up and down as a child tosses a ball." The channel between the Western Isles and the mainland is, like Cape Wrath, appropriately named "The Minch," which means "the stormy sea." In navigating this long channel the utmost skill and vigilance are required to avoid shipwreck on the rocky coasts, and to guard against collision with the numerous vessels compelled to traverse these dangerous waters.

THE PASSAGE OF THE ENGLISH CHANNEL. The passage to the south, round the coast of England, presents dangers of no less formidable a character. The immense number of ships continually passing to and fro in the English Channel render the risk of collision very imminent, particularly during the heavy gales and dense fogs frequently experienced in these narrow seas. The late Mr. Brebner, C.E., Edinburgh, in advocating his scheme for constructing a deep channel between the Forth and the Clyde, said: "As to the necessity for a ship canal between the two oceans, there can be little doubt. It arises from the difficulties and the dangers of navigation by the Pentland Firth, or amongst the Orkney Islands, or going south through the Channel, where there are frequent collisions and many sandbanks." Mr. D. A. Stevenson, B.Sc., F.R.S.E., M.Inst.C.E., Edinburgh, Member I.C.I.N., in his paper to the Congress, on the same scheme, says: "At present all vessels bound from the east to the west coast of Britain, or *vice versa*, have to pass round either end of the island, through the Pentland Firth, with its rapid tides and dangerous seas, combined with deceptive currents and prevalent fogs; or 'south about,' through the dangerously overcrowded English Channel, so frequently the scene of disastrous collisions. That these are no imaginary evils may be judged of from the fact that during the seven years—1882 to 1888—there were 31 strandings on the shores of Pentland Firth, between Duncansby Head and Cape Wrath, and that, so far as can be gathered from the wreck charts, there were 270 vessels, during the same period, in collision between the North Foreland and the Scilly Isles. It cannot be doubted, therefore, that a ship canal through the narrow neck of land which separates the east and west coasts of Scotland, capable of

carrying the largest vessels, would not only obviate all the dangers and delays incident to the 'north about' and 'south about' routes, but would effect much saving in time, in the cost of insurance, in tear and wear of vessels and their engines, and, hence, in the cost of transit; and would also, for strategical purposes, be of the greatest importance."

From the authorities quoted it must be held that the present circuitous routes involve serious risks to life and property. This project, if carried out, would obviate, to a large extent, the necessity for incurring these risks, and would undoubtedly preserve human life and valuable property which must otherwise be sacrificed. If no other argument could be advanced in favour of the project than that it would diminish the dangers to which the lives of sailors are exposed, it would be worthy of national support.

CHAPTER IX.

COASTING TRADE OF THE UNITED KINGDOM.

EXTENT OF THE TRADE. The coasting trade of this country is very large, and is growing rapidly every year. According to the Board of Trade returns for 1889, no fewer than 605,438 vessels entered and cleared coastwise, at ports in the United Kingdom in that year, embracing the enormous total of 89,556,083 tons. The principal ports in Great Britain and Ireland, from which this vast trade emanates, would all, with the exception of Southampton, benefit to a large extent by the proposed short and safe route. In view of the advantages that the canal would offer to these ports in expediting the working of this trade, it is not unreasonable to expect that from 5 to 10 per cent. of the ninety million tons would contribute to the revenues of the Canal Company, and that the new route would, in the near future, be found practically indispensable by an amount of coasting traffic equivalent to probably seven million tons per annum. The project, if carried out, would exercise a more beneficial influence upon the coasting trade than upon any other branch of commerce.

PROSPECTIVE REVENUE FROM COASTING TRAFFIC. By means of the proposed route between the principal commercial centres, east and west of the island, coasting vessels would be enabled to make a greater number of voyages in the year than has hitherto been possible. The traffic to and from Aberdeen, Dundee, Leith, Newcastle, and the adjacent ports on the east coast; and Glasgow, Greenock, Liverpool, Belfast, and the adjacent ports on

the west, probably amount to over 25 per cent. of the total coasting trade. If so, the saving in distance between those ports, as indicated in the following table, would almost inevitably attract at least a half of this traffic; and twenty years hence, assuming that trade continues to progress at the rate referred to in preceding chapters, a coasting traffic through the canal of ten or twelve million tons may reasonably be relied upon. If it can be shown that 25 per cent. of the total coasting traffic does not pass between the ports named, even stronger proof will thereby be afforded of the dangers and hindrances of the natural channels; of the necessity for the short and safe route of the ship canal; and of the prospective augmentation of the coasting trade that will follow its opening. As in the case of the Clyde Navigation, the Suez Canal, and many other inland waterways, the original plan would probably require to be extended to meet the demands made upon it. The difficulty would not be the scarcity, but the abundance of the traffic, and the additional space required to provide for its accommodation.

Assuming that seven million tons of the total coasting traffic utilised the canal, at an average tariff as low as 1s. 3d. per ton—equivalent to $\frac{1}{4}$ d. per ton per mile of the canal—which is less than the average dues on the Clyde, the revenue from the coasting trade *alone* would amount to £437,500 per annum, a sum sufficient to pay a large dividend on the estimated capital of £7,000,000, after providing for the cost of maintenance and all other charges.

DISTANCES SAVED BY THE SHIP CANAL. The following table shows *approximately* the distances that would be saved by coasting vessels plying between the ports named *via* the Forth and Clyde Ship Canal, as compared with the distances rendered necessary by the present detour *via* the Pentland Firth :

APPROXIMATE DISTANCES IN MILES.

				APPROXIMATE DISTANCES IN MILES.		Total Distances Saved by Ship Canal.	
				Via Ship Canal.	Via Pentland Firth.		
I. WEST TO EAST.							
Glasgow to London,				510	..	{ 1050	.. { 540
	via English Channel,	{ 880	.. { 370
..	Hull,			310	..	850	.. 540
..	Newcastle,			190	..	730	.. 540
..	Leith,			55	..	670	.. 615
..	Grangemouth,			35	..	690	.. 655
..	Kirkcaldy,			60	..	600	.. 600
..	St. Andrews,			100	..	640	.. 540
..	Dundee,			110	..	630	.. 520
..	Arbroath,			120	..	620	.. 500
..	Montrose,			130	..	610	.. 480
..	Stonehaven,			140	..	600	.. 460
..	Aberdeen,			150	..	590	.. 440
..	Peterhead,			180	..	560	.. 380
Average distance saved between Glasgow and east coast ports.				—	..	—	.. 510

APPROXIMATE DISTANCES IN MILES.

		Via	Via	Total Distances	
		Ship Canal.	Pentland Firth.	Saved by Ship Canal.	
(1) <i>British Ports.</i>					
Leith to Falmouth,	510	..	{ 980	.. { 470
	<i>via</i> English Channel,	—	..	{ 750	.. { 240
„ Cardiff,	460	..	{ 930	.. { 470
	<i>via</i> English Channel,	—	..	{ 950	.. { 490
„ Holyhead,	250	..	720	.. 470
„ Liverpool,	290	..	760	.. 470
„ Manchester,	320	..	790	.. 470
„ Barrow,	240	..	710	.. 470
„ Portpatrick,	150	..	620	.. 470
„ Ayr,	110	..	630	.. 520
„ Ardrossan,	100	..	640	.. 540
„ Greenock,	70	..	650	.. 580
„ Dumbarton,	60	..	660	.. 600
„ Paisley,	55	..	670	.. 615
„ Glasgow,	55	..	670	.. 615
Average distance saved between Leith and west coast ports,		—	..	500
(2) <i>Irish Ports.</i>					
Leith to Londonderry,	210	590	..	380
„ Belfast,	170	640	..	470
„ Dublin,	260	730	..	470
„ Cork,	440	910	..	470
„ Galway,	440	780	..	340
„ Sligo,	320	660	..	340
Average distance saved between Leith and Irish ports,		—	..	410

The saving of distance is only one element in determining choice of route, the mariner has in addition to study the prevailing winds and currents, and the avoidance of stormy seas and rock-bound coasts. The ship canal would present a short and safe passage through an industrial centre, as compared with a comparatively long and dangerous voyage along a barren coast. The opening of the canal would, in all probability, render the coasting trade *via* the Pentland Firth a thing of the past, as the opening of the Suez Canal has practically abolished the trade to the east *via* the Cape of Good Hope.

RATES LEVIED BY CLYDE TRUSTEES. According to the Rate Book issued by the Trustees of the Clyde Navigation, on 9th December, 1890, the "rates on goods conveyed upon, or shipped, or unshipped, in the river, or at the harbour, or using any transit shed or warehouse," are as follows: For goods not particularly specified—2s. per ton, foreign;—1s. 6d. per ton, coastwise;—1s. 6d. per ton per day on goods in transit sheds;—6d. per ton per week on goods in warehouses. The "rates on vessels on each time of entering or using or departing from the river or harbour," inwards and

outwards, are as follows: Coasting vessels, per registered ton, 3d.; foreign, 8d. Additional rates are specified.

The following are the stages of the navigation of the Clyde and rates thereon: "The *first stage* extends from Stockwell Street Bridge to the old ferry of Renfrew, being about 660 yards to the east of the present ferry, and the rates on vessels, goods, animals, and carriages passing in or upon any part thereof, are *two-third parts* of the aforesaid rates. The *second stage* extends from the old ferry of Renfrew to the mouth of Dalmuir Burn, and the rates exigible thereon are *one-sixth part* of the aforesaid rates. The *third stage* extends from Dalmuir Burn to Newark Castle, and the rates exigible thereon are *one-sixth part* of the aforesaid rates." It is important to note that the end of the proposed ship canal, debouching into the Clyde at Yoker, is *outwith* the boundary of the *first stage*, and, therefore, vessels using the canal would *only be liable to one-third of the Clyde dues*. In consideration of the great increase of traffic that would follow the opening of the canal, and the consequent increase in the revenues of the Clyde Trustees, a modification of the rates would probably be effected.

A large revenue is also derived by the Clyde Trustees from—(1) vessels entering or departing from the wet docks or tidal basins; (2) the weighing of goods; (3) the use of cranes, planks, stages, etc., for loading or discharging vessels; and (4) rates for the use of graving docks, ferries, passenger steamers, wharfs, tramways, quays, etc. A large revenue from similar sources would also accrue to the Canal Company.

CHAPTER X.

SHIP CANALS OF THE WORLD.

NATIONAL IMPORTANCE OF SHIP CANALS. The enormous development of steam navigation, in recent years, has produced, in many countries, a marked development in the facilities for the inland transport of large vessels by water. *The tonnage of the steamships of the world increased from 1,918,000 tons in 1870, to 11,552,000 tons in 1888.* This marvellous increase in the capacity for the rapid and economical carriage of commodities, while it has developed commerce, has, at the same time, transformed the character of the national competition for that commerce. Arguments, therefore, that could perhaps have been relevantly used, a few years ago, against the promotion of the Forth and Clyde Ship Canal, do not now apply. However

adequate the facilities are at present, or have been in the past, for the inland transport of heavy materials, in view of the development of British trade, from an average of £280,000,000 in 1855-6-7, to £648,000,000 in 1882-3-4, these facilities form no criterion of the requirements of the future. This project is intended for the benefit of commerce, and, from a national point of view, it should be considered in relation to the probabilities of the future, based upon the experiences of the past. It has been found necessary to increase the number and tonnage of ships to an enormous extent during the last twenty years. Short and safe national waterways for these ships, are as essential as the ships themselves, and such waterways ought, therefore, to be increased in the same proportion. Hundreds of millions sterling will be expended upon ships, in the immediate future, by the nations that would be included in the sphere of the beneficial influence of the Forth and Clyde Canal, and particularly by Britain. That being so, it is reasonable to urge that this project for increasing the utility of, and decreasing the risk to, a large part of the shipping of these nations, should be promoted.

The rush of trade to this country, shown by the above figures, rendered the Government, the manufacturers, and the merchants, oblivious to the necessity for maintaining and increasing the economical means of transport. The effects of this neglect are now beginning to be felt. The comparative dearth of wealth and commerce of several continental countries, enabled them the more readily to recognise the fact that the new conditions imposed upon the maintenance and development of national trade, by the numerous applications of steam power, have rendered the cheap inland transportation of heavy materials a vital necessity. The early recognition of this fact, and the consequent construction of large and efficient waterways, has placed many foreign countries, recently far behind us in the competition for commerce, in many respects on an equality, and in some instances in the forefront. To enable this country to maintain its position it is necessary that the cost of inland transport of heavy materials should be reduced to the level of these competing countries. This can only be accomplished by extending our inland navigations.

Judging from the following brief review of the leading features of the more important ship canals of the world, there can be no doubt that this project, if carried out, would ensure another lengthened period of prosperity to central Scotland, and, at the same time, confer important benefits on the nation at large.

<p>THE AMSTERDAM SHIP CANAL.</p>	<p>Several of the ship canals of the world possess numerous points in common with this project. One of these is the ship canal from Amsterdam to the North Sea. Formerly the access to Amsterdam was by the natural channel through the Texel Roads and the Zuider Zee. This passage resembles, on a small scale, the</p>
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passage of the Pentland Firth and the Minch, both being beset with dangers of a somewhat similar character. To lessen these dangers and improve the access to their great commercial port, the inhabitants of Amsterdam have spent millions of money, first, on the Zuider Zee, and, thereafter, in constructing a ship canal, with locks, through North Holland from Amsterdam to the Texel Roads. This canal, which is about 50 miles long and 20 feet deep, was completed in 1825. M'Cullough, in his *Commercial Dictionary*, describes it as "The greatest work of its kind in Holland, and probably in the world." It maintained and increased the trade of Amsterdam, and Holland generally, for a long period. The competition developed in recent years by steam navigation and railways, however, threatened to ruin the trade of Amsterdam, unless a shorter passage to the North Sea could be constructed. The city was consequently under the necessity of providing a direct route to the North Sea. This route lies across the neck of land known as the Sandhills. Great engineering difficulties were presented in the construction of this canal by the fact that the surface level is lower than the level of the sea. At the North Sea entrance many attempts at the formation of a harbour resulted in failure before a suitable entrance could be obtained. The canal is approached by locks at each end to lower vessels to the surface level. In addition to the North Sea harbour, a great dam about 4,500 feet long, shutting off Lake Y from the Zuider Zee, had to be constructed, to prevent the sea from flooding the canal. The drainage of a large area is received into the canal, and the surplus water is lifted, and discharged into the Zuider Zee, by three large centrifugal pumps, capable of raising together about 450,000 gallons of water per minute. A large part of the material was dredged at a cost of about 2d. per cubic yard. The largest lock is 390 feet long and 60 feet wide. The total expenditure was about £3,000,000. As regards its success, Mr. L. F. Vernon Harcourt, M.A., M.Inst.C.E., in his "Treatise on Rivers and Canals" (1882), says: "A large and rapidly increasing traffic passes through the canal, and the great benefit conferred by its construction upon Amsterdam is fully established."

A glance at the position of the Amsterdam Ship Canal, and the proposed Forth and Clyde Ship Canal, as delineated upon the map of Europe, will show the relative importance of the two projects for the development of commerce. The maximum saving in distance by the latter is five times greater than by the former. The British canal would possess local, national, and international advantages, while the Dutch is almost entirely local in its character. Many other advantages of the proposed canal, as compared with the Dutch undertaking, are too obvious to require comment.

BELGIAN SHIP CANALS. Belgium possesses, in addition to a complete railway system, a large number of canals and canalised waterways. The question of cheap transport has been carefully studied, and,

notwithstanding the great railway facilities, over 30,000,000 tons of goods are annually carried on the canals of this small country. Mr. Jeans says: "There is no country that enjoys the advantages of such cheap railway transportation, generally speaking, and yet there is no country that makes a more extensive use of its canal communications. Although Belgium has limited coal and iron resources, it has, nevertheless, by means of its cheap inland transport, been able to maintain a larger industrial population, in proportion to its extent, than any other European country."

The principal ship canals are those from Ghent to the Schelde, and from Ostend to Bruges. No fewer than twenty steamers from Britain alone, utilise the former in bringing weekly supplies of pig-iron, coal, and merchandise of various kinds to Ghent.

As regards the Bruges Ship Canal, Mr. Jeans says: "The enormous difference that results to the prosperity of a city from the possession of facilities for the navigation of vessels is well illustrated in the case of the old town of Bruges. About the beginning of the thirteenth century vessels sailed into the port of Bruges from all quarters of the world, and poured into her markets the trade and wealth of the south and east." At various periods, since the thirteenth century, the improvement of the waterway to Bruges has given a great impetus to the trade of the city. In those periods when the canal was closed to navigation, commerce practically disappeared, while in those periods when large ships could reach her wharfs, Bruges became one of the principal marts of the world.

The Schelde navigation likewise affords a striking example of the effect of cheap inland transport upon the commercial prosperity of a city. Prior to 1863 the Dutch Government levied duties upon all vessels using the Schelde. In that year, however, the various countries interested combined and purchased from Holland the right to levy such duties. Of the purchase price of nearly £700,000, more than one-half was paid by Britain, and fully one-sixth by North America. Mr. Jeans says: "Since then the trade of Antwerp has advanced by leaps and bounds. Between 1862, the year previous to the abolition of taxes on shipping, and 1887 the importations into Antwerp had increased by 335 per cent., and the exportations from Antwerp had increased by more than 500 per cent. In the general transit trade the increase was equally striking, amounting to about 400 per cent. The tonnage of vessels entering the port of Antwerp, within the same period, advanced by about 600 per cent. The actual figures were: Importations by sea,—1862, 568,871 tons; 1886, 2,438,178 tons. Exportations by sea,—1862, 177,702 tons; 1886, 821,753 tons. Tonnage of ships entering Antwerp,—1862, 599,899 tons; 1886, 3,658,900 tons. The abolition of the taxes levied previous to 1863 has had the effect, coupled with a judicious development of the shipping facilities of the port, of placing Antwerp at the head of the maritime ports of continental Europe, as regards both the volume of its

trade and the low rate of freight that may be obtained thence for nearly all the other ports of the world."

The Belgian ship canals testify to the enormous development of the commerce of inland towns when placed in direct communication with the great traffic of the North Sea. Ghent, Bruges, and Antwerp may be compared to Glasgow in their dependence upon their waterways for the maintenance of their trade. The opening of the Forth and Clyde Ship Canal would enable Glasgow, in addition to its present trade, to tap the source from which the flourishing towns of Belgium derive their commerce. From the relative position of the Belgian waterways, compared with the proposed British waterway, as shown by the map of Europe, it is evident that the latter would possess national and international advantages awaiting in the former, and that its prospects of financial success would be greater, from the fact that its sources of revenue would be more numerous.

THE BALTIC SHIP CANAL. The work on the new ship canal between the Baltic and the North Sea will probably be completed in 1893. As shown on the map of Germany, the canal extends from Kiel, on the Baltic, to the Elbe. It is over 60 miles long, and 90 feet broad at the bottom, with a depth of 28 feet. As the Forth and Clyde Ship Canal would be of great importance to this country in the event of war, so, in like manner, will the Baltic Ship Canal be of the utmost service to Germany, if that country is involved in hostilities with a first-class naval power. Without the ship canal an enemy might shut up the German navy in the Baltic. This is, in itself, an all-sufficient reason for carrying out the undertaking. The other reasons are the preservation of human life and property from the dangers of the navigation of the Kattegat and the Skager Rack, and the development of the commerce of Kiel, which occupies the situation in relation to the Baltic Canal, that Glasgow would occupy in relation to the Forth and Clyde Canal. The cost of the canal is estimated to amount to about £8,000,000.

The Baltic Ship Canal is very similar in its local, national, and international aspects, to the proposed Forth and Clyde Canal. About the same distance would be saved, and similar dangers obviated. Trade would be developed in the districts traversed in time of peace, and like advantages would accrue in case of war. German statesmen have recognised the important bearing of the Baltic Canal upon the national scheme of coast defence, and the Government have been prevailed upon to give substantial aid in the construction. As the Forth and Clyde Canal is equally, if not more, essential in the scheme of coast defence of the United Kingdom, the British Government should be urged to adopt a similar policy in this respect.

ISTHMUS OF CORINTH CANAL. The project for constructing a waterway through the Isthmus of Corinth, in its local, national, and international characteristics, likewise bears a strong resemblance to the project

for cutting a waterway between the Forth and the Clyde. Locally the districts of both routes abound in minerals. It is, therefore, expected that the Corinth Canal will transform the town of Kalamakis into an important maritime port; that it will resuscitate numerous ancient Greek cities, long since abandoned, and make them again busy centres from which the minerals of the district may be exported. Similar expectations are formed regarding the development of the towns on the route of the proposed Forth and Clyde Canal. Both canals would confer national benefits by bringing the chief ports of the respective countries into more direct communication by sea, while the dangers of the coast of southern Greece, in the one case, and of the Pentland Firth and the English Channel, in the other, would be avoided. The Hellenic Government have recognised the national advantages of the project, and granted to its promoters all the land required for the canal, with over 12,000 acres on each side in addition, together with powers to work the mines, quarries, and forests within a radius of about 20 miles from the canal. The international features of the two projects resemble each other in that, in the one case, vessels passing from the Mediterranean and Adriatic Seas to the Archipelago and the Black Sea require to make a detour of over 200 miles; while, in the other case, vessels passing from the Atlantic Ocean to the North Sea require to make a detour of, on an average, 500 miles.

The probable traffic of the Corinth Canal has been estimated at 4,500,000 tons, that of the Forth and Clyde at double that amount. The bottom width of the former is fixed at 72 feet, and its depth at 26½ feet. The length of cutting is only four miles; but this is counterbalanced by the difficulties of the excavation, there being a cutting required of nearly 300 feet through hard rock, necessitating blasting and the use of the pick. The capital of 63,000,000 francs was readily subscribed, and the works have been commenced.

The main difference between the two undertakings lies in the fact that Greece is a comparatively small country with little commerce, and that the financial prospects of the Corinth Canal must necessarily be very inferior to those of the Forth and Clyde Canal, which would form part of the chief centre of the shipping trade of the world.

THE SUEZ CANAL. The proposal brought forward in 1856, by M. de Lesseps, to construct a waterway across the Isthmus of Suez, was received in this country with the most determined opposition. The Government, headed by Lord Palmerston, then Prime Minister, and British engineers, headed by Robert Stephenson, strongly condemned it. Both Lesseps and his scheme were "denounced from platform and press in the most unsparing manner." The *Edinburgh Review*, January, 1856, described it as "utterly impracticable," and urged that "the available population or resources of Egypt could not execute such a work in a hundred years," that "an army of foreign navvies would be required to keep in repair such a work

with its locks, viaducts, steam engines, and a floating capital hardly inferior to the original outlay." When this review is compared with the accomplished work, it is evident that the writer had not studied the details of the project. He condemned, not Lesseps' scheme, but a figment of his own brain. The success achieved by Lesseps shows the nature of the injury that may be, and frequently is, inflicted upon commerce by such writers. In projects calculated to influence the myriad ramifications of trade, a sound judgment upon their practicability and utility can only be obtained by summing up the opinions of experts in the various branches of the subject. The writer in the *Edinburgh Review* usurped the position of these experts, and thereby injured, at its inception, a project which has since proved itself to be of the utmost importance to the development of commerce.

The *Quarterly Review* likewise conjured up a perfect phalanx of objections and obstacles that it declared could not be overcome. Mr. Jeans says: "It is not in the least discreditable to Palmerston that he should have failed to realise how completely his anticipations would be falsified by events. No one at that time could have foreseen that, in less than thirty years from that date, the Suez Canal would not only have become an accomplished fact, but would have become, perhaps, *the most successful industrial enterprise of modern times*; that it would have revolutionised our shipping and transit trades; and that our Indian and Australian possessions would have participated in its advantages to an enormous degree."

About £20,000,000 have been expended upon the canal. The shares are now valued at four times that amount, and the canal is therefore now worth about £80,000,000. The shares rose from 306 francs in 1867 to 2,710 francs in 1882.

The Suez Canal and the proposed Forth and Clyde Canal possess few points in common. From an international point of view the Suez Canal has acquired an importance that can never be attained by the Forth and Clyde Canal. On the other hand, the local and national importance of the latter is greater than the former. The one passes through a barren desert, the other would traverse a rich mineral country and a great centre of trade. From a national point of view the Forth and Clyde Canal would benefit a larger proportion of British shipping than the Suez Canal. Probably both are equally essential in their respective spheres.

THE PANAMA CANAL. It has been remarked that the project for the construction of a waterway across the Isthmus of Panama has, so far, proved a failure, and inferences have been drawn from this fact relative to the project of the Forth and Clyde Canal. Such inferences, however, are not well founded. As regards the physical difficulties of construction the two projects cannot be placed in the same category. In forming the Panama Canal it was necessary to control, by means of

enormous embankments, the waters of a torrential river liable to rise about 40 feet above its normal level by the tropical rain of a single day. This river, the Chagres, crosses the line of the canal no fewer than 27 times. It was necessary to cut through rocky hills to a depth of 300 feet in some places. It was necessary to endure a malarious and deadly climate, where the annual rainfall is from ten to fifteen times greater than that of Europe, the rain falling almost continuously for about one half of the year, with few fine days during the other half; where mortality is consequently excessive, and labour scarcely to be had at any price. These are only a few of the difficulties of the most colossal undertaking of ancient or modern times, difficulties in comparison with which the work of clearing the ancient natural channel between the Forth and the Clyde would be insignificant. The cost of the Panama Canal, to the present time, amounts to about £60,000,000.

According to the *Paris Figaro* of 19th January, 1891, an agreement has been concluded between the Government of the United States of Columbia and the Panama Canal Company, by which the time allowed for the completion of the canal is extended for a further period of ten years. The project may yet become an accomplished fact to the great benefit of international commerce.

THE NICARAGUA CANAL Another gigantic undertaking, with the object of dividing North and South America by a waterway, has recently received the sanction of the United States Government under the title of "The Maritime Canal Company of Nicaragua." A number of engineers and surveyors, with a large quantity of machinery, are now engaged in the work, and the reports of progress are, so far, favourable. An account of the locks for this canal is given in the foregoing chapter on the "Geological Features of the District."

The published report of the Canal Company contains an interesting statement on the possible traffic as follows: "The capacity of the canal for traffic will be limited only by the time required to pass a lock. On the basis of 45 minutes (usual time, 10 to 15 minutes) as the time consumed in the operation, and that but one vessel will pass in each lockage, the number of vessels which may pass through the canal in one day is calculated at 32, or, in one year, 11,680; which, based on the average tonnage of vessels going through the Suez Canal, will give an annual capacity for traffic of over 20,000,000 tons; but two vessels, each of 2,000 tons displacement, may be passed through on each lockage, thus largely increasing, if not doubling, the estimated capacity." From this it is evident that the capacity of the Forth and Clyde Ship Canal, as proposed by Messrs. Crouch and Hogg, would admit of an annual traffic of 20,000,000 tons, provided larger reservoirs were constructed.

THE ST. MARY'S FALLS CANAL. The canal which connects Lake Superior and Lake Huron is, in some respects, the most remarkable ship canal in the world. It was constructed in 1854, and, during the first year after its opening, the traffic only amounted to about 100,000 tons. Now, however, the traffic amounts to over 6,000,000 tons per annum. "The staple articles of commerce using the canal are coal, copper, flour, grain, iron ore, pig and manufactured iron, lumber, salt, silver ore, and building stones. *Before the opening of the canal the commerce here was NIL.* It now threatens to exceed the capacity of the locks, in view of which the United States Government has commenced a new lock, which is to surpass all other locks in the grandeur of its dimensions. It will have a chamber 800 feet long between the gates, the width will be 100 feet throughout, and the depth on the sills will be 21 feet. It is designed to pass a fleet through at a single lockage. This lock will be the largest in the world. *The navigation is only open for about seven months in the year,*" which means an average of over 900,000 tons per month passing through the canal, or at the rate of about 11,000,000 tons a year. The lock that passes this enormous tonnage is 515 feet long between the gates, and 80 feet wide in the chamber, with 17 feet of water on the sills. The lift is 18 feet. Again we have evidence that the locks for the Forth and Clyde Canal could, with an addition to the water supply, pass through a traffic of 20,000,000 tons per annum, if necessary.

THE MANCHESTER SHIP CANAL. This project was approved of by no fewer than six committees of the House of Commons, the first select committee being so convinced of the necessity for the undertaking that, acting without precedent, it inserted, on its own initiative, the following clause in the Bill: "And whereas it appeared from the evidence adduced that, if the scheme could be carried out with due regard to existing interests, the Manchester Ship Canal would afford valuable facilities, and ought to be sanctioned." As similar reasons for opposition do not exist in the case of the proposed Forth and Clyde Ship Canal, and as it partakes more of the character of a national and international undertaking, probably the approval of one committee of the House of Commons would suffice.

The total authorised capital of the Manchester Ship Canal is £9,812,000, as compared with £7,000,000 estimated for the Forth and Clyde Ship Canal by Messrs. Crouch and Hogg. The total length of the former is over 35½ miles, and the summit level 60 feet 6 inches. The total length of the latter would be under 30 miles, and the summit level 95 feet. The minimum width of the Manchester Canal is to be 120 feet on the bottom, and depth 26 feet, as compared with Messrs. Crouch and Hogg's estimate of 100 feet of bottom width for the Forth and Clyde Canal, and depth of

26 feet. The width on the bottom and depth of other ship canals are: Amsterdam, width 88 feet 7 inches, depth 23 feet; Ghent, width 55 feet 6 inches, depth 21 feet 2 inches; Suez, width 72 feet, depth 26 feet. The largest locks of the Manchester Ship Canal are 550 feet long, 60 feet wide, and 15 feet vertical lift, and will admit the heaviest merchant steamers afloat. Each set of locks will be worked by hydraulic power, enabling vessels to pass through in 15 minutes. Messrs. Crouch and Hogg propose for the Forth and Clyde Canal locks 600 feet long, 65 feet wide, and 16 feet vertical lift.

The engineers of the Manchester Ship Canal estimate that vessels will navigate the canal at an average speed of five miles an hour, the whole journey being accomplished in about seven hours, which is a shorter time than is necessary to cart goods from ship to rail in Liverpool, and convey them by rail to Manchester. At the rate of five miles an hour on the Forth and Clyde Canal the journey between Yoker and Grangemouth would be accomplished in about six hours.

The Manchester Canal is to be completed, under contract, next year, 1892. The promoters estimate a traffic of 3,000,000 tons per annum, yielding a net annual income of £709,000. Allowance for the future expansion of trade, the coasting traffic, and the carriage of goods such as iron, coal, and salt are not included in this estimate. An estimate, submitted to Parliament, embracing these items, brought out an annual traffic of over 9,500,000 tons, and a net annual revenue of over £1,500,000. The Manchester Canal is a local waterway, available only for ships trading with the city of Manchester and district. The Forth and Clyde Canal would confer nearly, if not quite, as great local benefits on the city of Glasgow and district, and it would, in addition, be available as a national highway for ships trading between nearly all the ports of the United Kingdom, and as an international highway for ships trading between this country and northern Europe and America. It is, therefore, reasonable to estimate that the returns of the latter would, at least, equal those of the former. That being so, an estimate of a net annual revenue, from all sources, of over £1,000,000 is well within the bounds of probability.

MR. LEADER Messrs. D. & T. Stevenson, an eminent firm of civil **WILLIAMS' VIEWS.** engineers, recently brought before the public a proposal for the construction of a ship canal between the river Forth and the Firth of Clyde by way of Stirling, Loch Lomond, Tarbert, and Loch Long. It is understood that this proposal has now been abandoned. Mr. Leader Williams, chief engineer of the Manchester Ship Canal, in his published report upon the project, dated 4th October, 1889, expressed the following opinions: "The proposed Forth and Clyde Ship Canal is a work that, if carried

out, would obviously be of *great benefit to maritime commerce*. The rapid and continuous increase of steamers over sailing vessels, and the ease with which large steamers pass the Suez, Amsterdam, Ghent, and other ship canals, has prepared the way for inland canals of large size. The necessity of economising time, in order to save expense, will ensure a large trade through the canal, not only by steamers, but by sailing vessels towed by steam tugs. Contrary winds often cause great delay to such vessels, more particularly when they have several times to change their course, on a roundabout coasting voyage. *The saving of distance would be great*, and the diminished risk in navigating a long line of coast, which is of a *peculiarly dangerous character* in rough and foggy weather, would *ensure constant trade* to the canal. In case of war the canal would be of national importance. It would form a *safe harbour*, uniting two seas on opposite sides of our shores, into either of which a fleet could steam as necessity arose. It would also *increase the strength of the navy* by the facilities it would afford in the defence of our coasts by bringing the Atlantic and German Oceans into connection by a deep ship canal of comparatively short length. The rapid rate at which the works of the Manchester Ship Canal are now progressing towards completion proves that, if a ship canal is designed on the basis of careful surveys, an energetic contractor, with the aid of modern engineering appliances, can construct a large ship canal with the same certainty and speed with which the small barge canals of the last century were made. They are, in fact; similar works, varying only in magnitude and cost." These views on the national and commercial utility of a ship canal between the Clyde and the Forth, by one of the highest authorities, necessarily carry great weight in favour of the construction of a ship canal by whatever route it may proceed.

PROPOSED SHIP
CANALS OF THE
UNITED KINGDOM.

Mr. Stephen Jeans, in his work on "Waterways," says : "One of the most notable features of the engineering and commercial development of to-day is the movement for making ship canals. At the present moment the principal proposals affecting the United Kingdom are: (1) The construction of a national canal passing right through from the Bristol Channel to the Humber, on the one side, and from the Thames to the Mersey, on the other. (2) The conversion of the existing waterways into a ship canal between Sheffield and Goole. (3) *The construction of a ship canal between the Forth and the Clyde.* (4) The construction of a ship canal between the Mersey and the city of Birmingham, connecting with the Manchester Ship Canal and the Mersey, by way of the Weaver navigation.

"The most probable, and, at the same time, one of the most important of the foregoing proposals, is that designed to connect the Forth with the Clyde, thereby enabling vessels to pass from one sea to the other without passing round the further extremity of the island. For channel steamers going from

Ireland, the west coast of Scotland, England, or Wales, to the east coast or the continent, the canal would be a decided benefit, for not only would their voyage be shortened, but the rocky and dangerous coast of the north of Scotland would be avoided. The canal would pass through the coal and oil districts of Scotland. Another consideration which carries much weight is the facility gained for the rapid passage of battleships from one shore to another, rendering defence in time of war more effective."

The *Scottish Leader* of 30th July, 1889, referring to the paper submitted by the author to the International Congress on Inland Navigation, at Manchester, says :

"Few great schemes have better natural recommendations than the Forth and Clyde Canal, and Mr. Law Crawford in his address of yesterday was able to make out a most impressive case. The shortening of communication between important industrial centres; the development of commerce both on the east and the west coasts; the opening up of new enterprises may all be safely predicted from the formation of a water highway across Scotland. From the point of view of national defence, the scheme has also most obvious advantages; so obvious, indeed, that Government assistance in carrying it out could hardly be withheld. It would be no unworthy national ambition to aim at realising the project in the near future. Mr. Law Crawford is sanguine that it can be made financially sure; and his address certainly helps to bring it within the sphere of practical things."

THE THAMES AND THE TYNE. Although the Thames and the Tyne are not, strictly speaking, ship canals, they serve the same purpose, and the remarkable development of their commerce may be here referred to, as that development has a direct bearing upon this project. The increase of the shipping trade of the Thames in recent years has been enormous. In 1860 the total entrances and clearances of the Port of London amounted to about 9,500,000 tons; it is now over 17,500,000. In 1860 the average size of the vessels trading to London did not exceed 210 tons. In 1886 the average had risen to 620 tons, an increase of about 200 per cent. At the Port of Liverpool the average size of vessels has increased to over 1,000 tons. A few years ago the average did not exceed 500 tons.

The Tyne is another striking example of the fact that facilities create trade. Like the Clyde, the Tyne has been transformed from a shallow river of about three feet in depth to a magnificent waterway of a uniform depth of nearly 30 feet. The Tyne Improvement Commission has expended about £4,500,000 on the undertaking, with the result that in 1888 no fewer than 20,761 vessels entered and cleared from the Tyne ports, the total tonnage amounting to 8,396,000 tons. The revenue has increased in a few years from about £100,000 to over £250,000 per annum. Mr. Jeans says: "This noble river, from Newcastle to the sea, is one of the greatest triumphs of modern engineering. No better example of what has been done within recent years in the way of providing additional facilities for the wants of British shipping could be quoted than the case of the Tyne. That river is the natural outlet of the

great northern coalfield. It is also the outlet for a very great trade in chemicals, engineering, iron and steel, and other industrial products." From their relative situations it is reasonable to conclude that the commercial success of the construction of the Forth and Clyde Canal would be even greater than that which has followed the deepening of the Tyne. The Kelvin valley district is the seat of a still larger trade in minerals, chemicals, engineering, iron, steel, and other industrial products. The ship canal would become, as the Tyne has become, a great outlet to the North Sea for local manufactures, and in addition it would have the advantage of forming a national and international highway for trade. The Thames derives its immense volume of shipping chiefly from the ports on the North Sea. The Tyne derives its trade almost wholly from the same source. Remove the barrier between the Clyde and the Forth, and the whole of central Scotland would be placed in direct water communication with these same ports. Glasgow already holds a great command over the Atlantic trade. Were the ship canal formed it would likewise obtain a command over the North Sea trade, and would thus be more favourably situated for the development of commerce than any other city in the United Kingdom.

CHAPTER XI.

THE SHIP CANAL IN THE EVENT OF WAR.

PUBLIC OPINION One of the greatest national advantages of the waterway
ON QUESTION across Scotland would be the security and protection
OF WAR. that it would afford, in the event of war, to the whole
of the United Kingdom, and consequently to the colonies and dependencies
of Britain all over the world. The possibility of this country being
involved in warfare with one or more foreign powers is a contingency
that is every year being more fully recognised. In the words of Von
Moltke: "Europe is bristling with arms." The present Parliament has
shown its sense of the danger by voting the enormous sum of twenty
millions sterling to increase the naval resources for the defence of the
country. The naval manœuvres of recent times have indicated the risks
to which the nation, and particularly the seaports and shipping trade are
exposed, and the conclusion has been arrived at that these risks must be
minimised as far as practicable. Public opinion has also been gradually

making its influence felt on the subject. It is now almost universally admitted that, in view of the stupendous increase of the naval and military forces of the great continental powers, every available bulwark of defence in this country must be strengthened and improved. The members of the present Government have responded boldly to the feeling of the nation. They have recognised the duty of making adequate provision for maintaining the prestige of Britain at all costs, and Parliament, with the sanction of the country, has unhesitatingly supported their proposals for strengthening the Royal Navy.

REASONS FOR INCREASE OF NAVY. That the expenditure of twenty millions sterling, for the augmentation of the navy, is necessary, is shown by the following table :

TABLE SHOWING THE NUMBER OF WAR VESSELS, AND THE PROPORTION OF MERCHANT VESSELS TO EACH WAR VESSEL, OF THE THREE LARGEST NAVIES IN THE WORLD.

Compiled from Lloyd's Register of Shipping.

PARTICULARS.	GREAT BRITAIN.	FRANCE.	GERMANY.
No. of 1st Class Armour-clads (18-in. armour and above), -	15	12	—
„ other sea-going Armour-clads, -	45	23	11
„ Cruisers and Sloops, -	111	59	28
„ Gun Vessels, -	44	14	5
„ Gun Boats, -	68	29	6
„ War Vessels steaming 14 knots and above, -	92	68	31
TOTAL, -	375	205	84
No. of Merchant Steamers to each Cruiser or Sloop, -	52	8	21
Amount of Merchant Steam Tonnage to each Cruiser or Sloop, -	63,000	12,000	24,000
No. of Merchant Steamers to each War Vessel capable of steaming upwards of 14 knots, -	62	7	18

It is evident from this table that, in the event of war, a very large part of our mercantile fleet would be in imminent danger of capture by the enemy. The naval manœuvres for several years have demonstrated this fact. It is clear that one cruiser would form a very inadequate protection for fifty merchantmen. Even the sum of twenty millions will not go far towards increasing the protection to reasonable proportions. Any project, therefore, which is calculated to free a large number of cruisers from the necessity for defending the coast, and which would thereby render them available for the defence at sea of merchant ships, demands the most serious consideration.

Admiral of the Fleet, Sir Thomas Symonds, has, says the London correspondent of the *Glasgow Herald*, sent a letter, dated 20th January, 1891, to the Prime Minister, demanding an inquiry on oath into the state of the first line of defence. In spite of the late special vote, he says that *we are especially short of cruisers*. The attendance on our battleships and other necessary duties would absorb them, and leave us with no protection for convoys, and the food to be brought, and the coals to be sent out. Our Naval Reserves, only partially trained, are about 20,000 men. The Naval Reserve of France alone is 104,000 seamen, and 26,000 marine and marine artillerymen. *We need twenty battleships and fifty cruisers ready for sea as a reserve*, and we have had, in the last few years, a lesson, for *eight of our battleships have become unfit for battle in six months of peace*; and it has taken us two months even to get ready the vessel to replace "the poor little *Serpent*." Nothing but an inquiry on oath, Sir Thomas is sure, will show "*how recklessly we are pursuing the road to ruin in the event of war.*"

THE SHIP CANAL
—A POWERFUL
AUXILIARY TO
NAVY.

One of the most effective means for protecting, not only the country but the great fleets of merchant ships, is undoubtedly to be found in the project now submitted. There cannot be the shadow of a doubt that a deep and broad channel across central Scotland, capable of accommodating war vessels, would form one of the most powerful auxiliaries to the Royal Navy that could be devised. By it a control could be exercised over the whole of the defending squadrons which would be impracticable under the present circumstances. The nation that can command short and safe channels for the rapid transit of its ships and materials of war, accessible to it but inaccessible to its enemies, has an undoubted advantage.

Mr A. B. Forwood, Financial Secretary to the Admiralty, in addressing his constituents at Seaforth, near Liverpool, on 19th January, 1891, said:

"I admit that the naval administration is closely bound up with the security of the empire, and I venture to say that closer attention has been paid of late to organisation for war, to *careful preparations to ensure rapid action in case of hostilities*, than has been the case for many years. Apart from the building of new vessels, older types have been remodelled, in machinery and armament, so as to be able to take their place in action; and hulks, that formerly did only as guardships, are now replaced by vessels able to sail at an hour's notice."

The *Evening Citizen* of 21st January, 1889, in a special article on "What to build for England's Navy?" says:

"Our mercantile marine is more than double that of Germany, France, Italy, Russia, and Austria all added together; yet it has been calculated that, admitting the obsolete and unready ships, *our available battleships only carry 300 heavy guns, with a total muzzle energy of 858,076 foot-tons; while the French battleships that are available carry 294 heavy guns, with a muzzle energy of 909,900 foot-tons, or actually more than ours.* Sir Geoffrey Hornby, by way of pointing out our requirements in battleships, supposed the case of a war between England and Russia, when, in addition to our fighting ships in the Pacific, Australian, and Chinese

stations, we should have to send fifteen battleships to the Black Sea, and fourteen to the Baltic, and asked how we should feel if there were any possibility of France attacking us with twenty-four battleships while ours were so scattered. The Admiralty propose to lay down both first and second class battleships during the next financial year, and there is no denying the fact that we urgently need all that Parliament is likely to vote, and a good many more."

GOVERNMENT AID IN CONSTRUCTION. So far as the Government is concerned, the proposed channel for war vessels could be constructed by the mere guarantee of a sum equivalent to the cost of three or four men-of-war. What are the comparative advantages? The ship canal would be self-supporting. It would be of incalculable benefit to the nation commercially; and it would be of vastly greater service, in the event of war, than three or four ironclads of equivalent cost, which, however necessary, are absolutely unproductive, involve an enormous outlay, not only in construction but in maintenance, are certain to become obsolete, and are liable at any time to be lost. As an illustration of this, it may be noted that, in September last, while the *Anson*, one of the latest first-class line-of-battle ships, built at a cost of £780,000, was in dock at Devonport, it was accidentally discovered that her shafting was so entirely defective that, had she proceeded to sea, she would have been in danger of "going to the bottom."

The *Glasgow Herald* of 22nd February, 1889, in a leader on the proposed Forth and Clyde Ship Canal and national defence, says:

"It is argued by some writers that the element of commercial success should not be allowed to enter into the discussion of this enterprise. If the development of the canal, they say, can be shown to be necessary for the interests of commerce, and still more for the movements of our navy, then it ought to be carried out irrespective of its cost. This, of course, alters the whole aspect of the questions at issue. It means that the proposed works must be constructed and maintained, not entirely by any private company, but, to a large extent, by the State. The canal, in fact, would have to be treated as part of the national defence; and just as no one thinks of asking whether the navy, or the army, pays, so the question could not crop up in respect of this piece of inland navigation. *It may be anticipated that this view of the matter will not be overlooked by the authorities, though in this, as in other points of national defence, the people generally ought to speak their minds. Governments, as Lord Wolseley remarked the other day, want to be stimulated by public opinion.* It may be thought that the rod is being applied freely enough in this way just now. Whilst Lord Charles Beresford has gone abroad on the search for new facts with which to carry on his campaign for naval reform, Lord Brassey has taken his place as chief assailant of Admiralty shortcomings, and delivered an address at the London Mansion House yesterday which ought to bear good fruit. If the report, which appears to-day, in respect of last year's naval manoeuvres, is to be credited, Lord George Hamilton's candid friends are even to be found in his own household. *All this ought to spur on the Ministry to deal boldly with what must be looked upon as the great necessity of the day. The problem of national defence must be solved somehow, and without much greater delay.*"

STRATEGIC POSITION OF SHIP CANAL. From a strategic point of view, the proposed ship canal would occupy the best position that could be selected in the length of Britain. Fleets from its western outlet, lying, as it does, at the northern extremity of Ireland, would

command the whole coasts of that island, as well as the west coast of Britain, on the one hand; while fleets from its eastern outlet would control the east coast of Britain and the North Sea, on the other hand. Without the canal it would be necessary to maintain large and independent fleets on both sides of Britain, as the fleet on one side would be practically powerless to aid in repelling an attack on the other side, owing to the delays and dangers of the northern and southern passages. By means of the canal fleets would be speedily available on either side. It is, therefore, obvious that the country itself could thus be defended with fewer ships of war, leaving a larger proportion for the protection of the merchant navy beyond our shores. A Reuter's telegram of 23rd December, 1890, says: "At a meeting held at Chicago yesterday evening, every reference to Fenians, an Irish Republic, and the use of physical force when England was involved in a foreign war, was cheered to the echo."

NATIONAL
DEFENCE.

Sir Charles Dilke, in a paper on "The Defence Expenditure of the Great Powers," read before the Royal Statistical Society on 16th December, 1890, says:

"We are spending, in the present year, over £33,000,000 out of taxes upon defence in the United Kingdom, and adding what we are spending out of debt, over £38,000,000. India is spending £17,000,000 upon defence, and with nearly £2,000,000 for the defence of the colonies, *we come up to £57,000,000 in the year*. The French spend £36,000,000 a year upon defence; the Germans are spending in the present year £38,000,000; and the Russians £28,500,000. *Our own expenditure is upon a far larger scale*, and puts us altogether before the other powers in the figures of defence expenditure, *although our lack of organisation is so complete that we are never prepared for war*.

"The moral drawn from the total failure of the French in 1870 to obtain even a momentary success, was that *war cannot be commenced, with a fair chance of winning, by a nation which waits until war to make her organisation perfect*. The authors of Prussian history find another cause of the French defeat *in the centralisation of the whole administration of the army in one place*. In the United Kingdom we have *only one centre* for each branch of our force. The last of the main causes given by the Germans for their easy victories also applies to us. They point out that the French army *had never been mobilised*. I need hardly say that *the same is true of the United Kingdom*.

"Although we are utterly unprepared (except in India) for the stress of war, we nevertheless spend sums so vast as to stagger and amaze even those French and German critics who ought to be pretty well used to large sums for military expenditure. *Three army corps in six weeks* as against *twenty army corps, or 800,000 men, in five days* for France or Germany, is what we have to show as the net produce of our fully paid non-conscript regular force. While the *armies of the British Empire cost about £35,500,000 a year*, in addition to the money raised upon loans, the German army costs about £33,500,000; and the French army a little over £28,000,000 in the year in all."

Referring to Sir Charles Dilke's paper, the military correspondent of the *Daily Graphic*, in the issue of 17th December, 1890, gives *the fighting strength of the armies of the Great European powers* as follows: Russia, 5,200,000 men; France, 3,409,000; Germany, 2,710,000; Italy, 2,550,000; Austria, 1,912,000; Great Britain (including 224,000 volunteers), 614,000; Indian army, 192,000.

In reply to certain criticisms on his paper, Sir Charles, in a letter to the editor of the *Daily Graphic*, in the issue of 25th December, 1890, says :

"Lord Wolsley has stated, 'that *the country pays, for an inferior article, a price that would be ample to give it a most efficient military machine.*' Lieut.-General Brackenbury, the head of the Intelligence Department, has told a committee, in evidence which has been published to the world, that *great economies might be made by decentralisation*, 'and, I believe, that the War Office, as now constituted, will never devise such a system.' He has, speaking of the home army, informed the committee that, '*owing to our defective organisation we should scarcely be able to put one army corps into the field.*' I do believe that, for the sum of money you are now spending, you might have a much better organised and a much more efficient army than the army you have now got.' Such are the opinions given by the Adjutant-General, who had been for several years at the War Office when he made his statement, and who has had greater experience of the British army and its cost, in recent years, than any other man; and by the head of the Intelligence Department, who has the best comparative knowledge of the armies of all countries possessed by any Englishman. Their views have since been confirmed by the report of Lord Hartington's Commission, and would, I venture to assert, be still further supported were it possible to publish the evidence upon which that report was founded. *I should like, in conclusion, to ask if any soldier seriously believes that the £57,000,000, now spent in a year for our defence, could not be so expended as to give us better defence than we possess for the empire at this moment.*

"With regard to invasion and the navy, it must be remembered that *the absence of means of defence on shore would certainly produce panic in time of war, and demands by the press that the navy should be tied to the Channel for defensive purposes*, instead of performing the proper duties of a marine. The Director of Transport has told us that *the invasion of England by France would be a 'perfectly practicable' operation.* If at any time we were to be driven into war with France and Russia, the French would, no doubt, attempt to decoy away our fleet and *make a dash at us*, and we are not in a comfortable position of preparation against such a dash."

These views of the highest naval and military authorities in their relation to this project may be briefly summed up as follows: (1) That we have too few ships and guns to defend the whole empire. The ship canal should therefore be constructed to increase the efficiency of the ships available for home defence. (2) That Governments require to be stimulated by public opinion. In view of the fact that the safety of the country may depend upon the construction of the ship canal, the Government should be strongly urged to give a grant in aid of the project. The local committees referred to in a former chapter could effectively move in this matter. (3) That we spend far more upon national defence than any other power. The canal, by making fleets available on both sides of the island, would reduce the expenditure and increase the security. (4) That we are never prepared for war. The canal would be of the greatest service in enabling the country to withstand any sudden attack. (5) That decentralisation is necessary, and would effect great economies. The position of the ship canal would form a most effective and economical centre for the military and naval administration of the northern part of the island. (6) That there ought to be occasional mobilisation. The canal would conduce to rapidity of mobilisation, either during peace or war. (7) That our army is insignificant in numbers in comparison with other powers. Every reasonable means, consistent with economy and

efficiency, should therefore be adopted to strengthen the position of the country. (8) That the absence of shore defence would produce panic in time of war. The canal would engender confidence, and, by diminishing the risk of panic, would enable a larger number of vessels to operate at a greater distance from the shore.

In support of a proposal to construct a ship canal between the Forth and the Clyde, *via* Loch Lomond, Colonel Adam, of Leith, wrote to the promoters, as reported in the *Glasgow Herald* of 20th November, 1889 :

"If the proposed canal between the Forth and Clyde be made deep enough to float line-of-battle ships, it requires no great knowledge of the art of war to see that such a strait might, in certain circumstances, *prove invaluable*, not only for the defence of the coast, but might even enable a concentration of our navy to take place *on the eve of a great naval engagement* upon which the future of the country might depend."

Colonel Malcolm on the same occasion wrote :

"Your project appeals most forcibly to me, as it must to all who consider the question of the defence of this country with any care. In the event of war such power of moving from coast to coast, *by a route inaccessible to the enemy, would be of inestimable value*. I could not say more if I wrote volumes."

DEFENCE OF THE FORTH. The following excerpts from letters addressed to the Admiralty, and the War Office, on 3rd March, 1890, by the Executive Sub-Committee of the Forth Defences Committee, convey a striking indication of the feeling entertained by the inhabitants of one of the districts of the country that would be exposed to the bombardment of a hostile fleet, in the event of war, under existing circumstances; but which would be practically freed from danger by the construction of the proposed ship canal :

"This Committee (the Forth Defences Committee) assumes that, as in former times, *in the event of war being imminent or declared, it is intended that some form of floating defence should be sent to these parts of the coast which are most open to, and most worthy of, attack*; and it may, therefore, be assumed that one or more ships would be sent to the Forth to replace the *Devastation*, which, at such a time, would probably be ordered elsewhere. In a complete system of defences some form of mobilisation, involving the allocation of fighting ships or floating batteries to the exposed commercial ports, must exist. This Committee's suggestion was, and is, that *it would be practicable, highly expedient, and economical to put such a scheme into operation*, at least to the extent of decentralising ships and materials in time of peace."

"For it is evident that the carrying out of any scheme of mobilisation must involve a very large amount of decentralisation; and *when there are taken into account the sharp and short way in which wars are now sprung upon nations; the very little time which might be available in such an emergency*; the possibility that the outfit and despatch of the vessels, intended for (say) the Firth of Forth, might be seriously and dangerously delayed by the great pressure of work in the great naval stations where these vessels are at present; the possibility of heavy weather at sea interfering with the passage of gun-boats and torpedo boats of poor sea-going qualities; and the chance of the capture of the latter by hostile cruisers of heavier armament, unless they are under escort; *it would seem to be very doubtful whether the nation could rely upon any scheme of naval*

mobilisation being carried out in a hasty manner and under pressure. Further, in the event of the occurrence of strained relations with a foreign power, the process of mobilising, if carried out at such a time as a precautionary measure, would at once excite the suspicions of that power, and might tend to provoke a rupture."

"All this points to the need of avoiding a policy of leaving everything to the last moment, and therefore emphasises the great desirableness of sending to their own proper district (e.g., to the Firth of Forth), in time of peace, such an efficient warship with modern armament, along with the flotilla of gun-boats and torpedo boats as would no doubt be attached to those districts during war; making at the same time the necessary local arrangements for the housing of stores, etc., for such vessels, and for the training of the local naval volunteers, of all classes, in modern gunnery and torpedo practice."

"A great naval war in which this country may be involved will necessitate a great demand for seamen on the part of the Admiralty."

"As the necessity for maintaining the transoceanic supplies of food and raw material will compel a much larger proportion of our mercantile fleet to keep the seas than has ever been the case in former great naval wars, the Admiralty will not be able to draw unlimitedly upon the mercantile marine for recruits."

"The inhabitants of this district (the Firth of Forth district) whom this Committee represents, are naturally anxious about their probable fate in time of war, considering how easy it is for an enemy to get into the Firth of Forth, and, what is quite as much, if not of greater importance, how easy it would be for a hostile raider, after inflicting serious damage, to get out again, clear away into the open expanse of the North Sea."

"There is no doubt that, if the defences of the Forth to the eastward of Edinburgh are ever forced by an enemy, the whole district, including the coal-loading ports, with their docks and warehouses, the shipping in the anchorages immediately to the west of Inchkeith, and the city of Edinburgh, will be at his mercy. No amount of defences at Queensferry can prevent this, and from this point of view the defences on and around Inchkeith are of paramount importance."

(Signed)

JOHN BOYD, Lord Provost, *Chairman*.

G. C. H. KINNAR, Colonel 1st Mid-Lothian A.V., } *Conveners.*

JAMES CURRIE, Shipowner,

J. BOLAM, *Hon. Secy.*

These excerpts speak for themselves. They undoubtedly give powerful support to the arguments advanced in favour of a Government grant being given towards the cost of providing this necessary channel for the ships of the Royal Navy. The scheme of naval mobilisation, referred to by the Committee, could be greatly simplified and expedited were the ship canal available at the outbreak of hostilities.

By the construction of the ship canal, the Forth and the Clyde would become, in the event of war, the chief rallying points for the squadrons defending the east and west coasts of Britain, and the danger of bombardment and invasion naturally apprehended "*by the citizens of Edinburgh, and other persons living on the shores of the Firth of Forth*" would practically cease to exist. No enemy, however daring, would be so foolhardy as to court inevitable destruction or capture by attempting to force one of the headquarters of the British navy. The cities and towns in the vicinity of the canal would thus be securely protected, and

British ships hard pressed by the enemy could unhesitatingly speed for the safe haven of the Clyde or the Forth. St. Margaret's Hope, in the Firth of Forth, is said to afford in every respect the safest anchorage on British coasts for large fleets.

The ship canal would justify the Admiralty in saving the expense, to a great extent at least, of providing and maintaining in the Forth the "*efficient warship with modern armament, along with the flotilla of gun-boats and torpedo boats*" demanded by the Defence Committee; and the War Office could substitute an efficient and economical scheme, in place of their elaborate plans for providing submarine mines at Inchkeith and Queensferry. The quick-firing guns desiderated for the protection of the mine fields, as well as the batteries at Inchkeith, Kinghornness, Queensferry, and Portobello could also be dispensed with. The money thus saved would go far towards providing the guarantee fund for the construction of the canal.

From the report which appeared in the *Glasgow Herald* of 22nd December, 1890, regarding the extensive fortifications now in course of construction on the island of Inchkeith, it is evident that the Government fully appreciates the danger to which Edinburgh, and the towns on the Firth of Forth, would be exposed in the event of war. It is obvious, however, that the stationary battery, upon this island, would not have such a restraining influence upon hostile cruisers as the constant presence of a powerful fleet on the canal route.

BRITAIN'S NAVAL NECESSITIES. Captain C. C. Penrose Fitz-Gerald, R.N., the author of the article on Naval Strategy and Tactics in the latest edition of the *Encyclopædia Britannica*, says: "*To Great Britain alone of the great powers of Europe are the problems of naval strategy of paramount importance. Upon a thorough knowledge and just appreciation of them, with a sufficient provision of physical force to secure their successful development in her own interests, depends the existence of the British Empire. The two principal objects of the naval strategy of Great Britain—the command of the narrow seas around her coasts and the protection of her merchant marine—are to a certain extent different, though not actually independent of each other. Thus she might, by providing an overwhelming fleet of ironclads, and neglecting to build a sufficiency of fast cruisers, retain undisputed command of the narrow seas, and yet have her commerce swept off the ocean by an enemy provided with numerous fast and far-ranging cruisers; and, on the other hand, it would be useless for her to provide vast numbers of vessels of the latter class to protect her commerce all over the world, if, by neglecting her ironclads, she lost command of the narrow seas, and saw her merchant ships captured in sight of their ports.*"

It is obvious, therefore, that her only safety depends upon an ample supply of both."

COMMAND OF
THE
BRITISH SEAS.

We have here an eminent authority declaring that the existence of the greatest empire in the world depends upon the command of the narrow seas around her coasts. Assuming this country to be involved in war with two of the great powers of Europe, the question arises: Would her fleet be sufficient to give her command of these narrow seas, and at the same time protect her mercantile marine in all parts of the world? From the statistics of the foregoing table grave doubts may be reasonably entertained by the public on the point, while the recent vote of twenty millions indicates that Her Majesty's advisers are by no means satisfied that our fleet would be sufficient. Another question presents itself: Would the construction of the proposed waterway improve the position, and help to remove these doubts? It must be admitted that the United Kingdom, with the aid of the canal, could be more securely guarded with fewer ships than as it is situated at present. Further, were the canal in existence in time of war, the enemy would be unable from reconnoitring to judge, with any degree of accuracy, the strength of our naval forces on either side of the island, from the fact that these could be increased or diminished at any time outwith the possible range of his observation or knowledge. The ship canal would thus tend to assure Britain of one of the essential elements of safety desiderated by this naval authority, viz., "the command of the narrow seas around her coasts." That being so, the nation naturally would have a much greater sense of security in any emergency that might arise; while the knowledge of this additional power of defeating invasion would strongly deter an enemy from risking the attempt.

PROTECTION OF
THE MERCHANT
FLEETS.

The other object of the naval strategy of this country, insisted upon by the author of the article just quoted, is that the only safety of Britain lies in her having an ample supply of both ironclads and fast cruisers. Even with the additions now being made to the navy, we will be far short of having a sufficient number of war vessels for the protection of the United Kingdom, the colonies and dependencies, and the merchant fleets. The question again arises: Would the proposed waterway greatly increase the efficiency of the vessels charged with the protection of the home ports, and by so doing practically supply the place of an additional fleet? From the configuration of the British Isles it is calculated that the proposed short passage across Scotland would be equivalent to at least one-third of the number of vessels required to protect the country as it is situated at present. A large number of war vessels, therefore, that would otherwise be tied to the coast, would be free to act as convoys to the merchant ships

bringing the necessary supplies of food and material to this country from friendly nations.

THE SECRETARY FOR WAR ON THE POSITION. The Right Hon. Edward Stanhope, Secretary of State for War, in submitting the Army Estimates to the House of Commons on 19th February, 1891, explained the progress of the three great works undertaken by the Government during the last few years, and in the course of his speech said :

"What we undertook was the armament of our ports under the Imperial Defence Act. Whereas, three years ago, there was no single fortress within the empire in which any modern guns were effectively mounted, except the four large guns at Malta and Gibraltar, now every one of the important fortresses has largely increased powers of defence. *Amongst the places where important improvements have taken place* are Portsmouth, Plymouth, the Thames, Malta, and Gibraltar. The second great work was an improvement in barrack accommodation. The third great work has been the establishment of measures for *the speedy mobilisation of the forces in time of war.* After making provision for our ports and coaling stations, all the remaining forces are being organised into *an army of defence.* Centralisation of stores has, to a large extent, been effected, *so that they can be shipped at once* in case the forces have to be sent abroad. *In the event of an emergency the troops would at once be mobilised* upon their appointed stations, from which they can be sent at very short notice to any given part. I AM BOUND TO SAY WITH RESPECT TO HOME DEFENCE, WHERE WE ARE SPECIALLY DEFECTIVE, we are entitled to look with some confidence to the Volunteer Engineers that now exist."

Sir Charles Dilke has just stated to a Belgian journalist that the British army can only be "*mobilised very slowly.*"

The *Glasgow Herald* says : "Even Mr. Stanhope's official optimism leaves it *very doubtful whether we have any army*, in the strict sense of the word, *to mobilise.*"

The *Standard*, London, says : "Zealous as Mr. Stanhope is, and admirable as is the work he has already effected, he would probably acknowledge, if he could only divest himself of his official character, that *much remains to be done before the country can congratulate itself on being reasonably secure.*"

Mr. Stanhope explains : (1) That what the Government undertook was the armament of the ports of the empire, and that this has been done to a large extent. The question arises: Have the ports on the Clyde and the Forth been placed in an adequate position of defence? This question should be considered by the local committees referred to in a former chapter. In the event of war the enemy would endeavour to strike at the most vulnerable and vital points, consequently the strengthening of certain points renders other neglected points more liable to attack. (2) That provision has been made for the speedy mobilisation of the forces. Eminent authorities express grave doubts on the efficacy of the provision. (3) That stores are being centralised so that they can be shipped abroad, at once, in case of emergency. Stores may require to be sent from the Forth to Ireland, or from the Clyde to the Baltic.

Finally, the Secretary for War admits that home defence is in a specially defective condition, and the Press asserts that the country is by no means secure.

The powerful sway that the proposed ship canal would have in the protection of the United Kingdom, under the circumstances above contemplated, is too obvious to require special reference.

PROSPECTS OF WAR. Although the contingency of war happily appears very remote at present, the newspapers nearly every day furnish fresh evidence of the danger existing from the long pent-up floods of military power on the continent—floods that may at any time burst their barriers and threaten our shores with their destructive forces. One instance will suffice to show that even a single foolhardy individual in a distant part of the globe may be instrumental in bringing about a European conflagration. As is well known, the action in Africa of the Portuguese Major Serpa Pinto recently compelled the British Foreign Office to adopt drastic measures which roused the bitter enmity against this country of the whole nation to which the Major belonged. Had Portugal been one of the first powers of Europe, the ultimatum despatched by Lord Salisbury to the Government at Lisbon would inevitably have embroiled this country in a terrible war. A Russian, French, or German Serpa Pinto may become a primary factor in international politics at any moment.

GERMAN VIEW OF BRITAIN'S NAVAL POSITION. The *Daily Graphic* of 13th January, 1890, contained the following article bearing on this subject, entitled, "Vulnerable Britain." "The current issue of the German *Militaer Wochen Blatt* contains a highly interesting article on this year's naval manœuvres of the British fleet. In a war with Great Britain," says the writer, "the actual invasion of the country is absolutely impossible so long as the British fleet remains master of the high seas. To annihilate this fleet, is, however, not even admitted into the practical military calculations of the second most powerful naval power, namely, France. One can very well follow the reasons which prevent a power contemplating such a risky attempt, as long as there exists other means by which to arrive at the same goal—the victory over an enemy. These other means are given already in the case of Great Britain by its geographical, economical, and political situation. *Great Britain as an island is open to attacks from all sides.* The population is dependent for its food and raw material on the constant and uninterrupted supply from foreign ports. *Its political situation is such that a sudden famine, stagnation of trade, or a commercial crisis would doubtless lead to internal troubles.* Add to all these things a panic caused by the bombardment of a few coast towns, and it is apparent that the Govern-

ment might think it wise to concede the demands of the foe, whose exactions after all may possibly not even touch the vital interests of the nation. *The main force and strength of a power in a future naval war will rest with a numerous fleet of swift, well-armed cruisers, whose tactics it will be to intercept merchant vessels rather than to fight pitched battles, and to appear everywhere, like the Anson before Aberdeen, and at no point where an attack might be expected."*

This article presents the probable *modus operandi* of the prospective enemy in a very reasonable light. Assuming that the contingency of war has actually arisen, and that the enemy has resolved upon risking an attempt at invasion, Britain being an island and "open to attacks from all sides," as stated by the German author, the enemy would have the great advantage of being able to concentrate his forces and strike at some unexpected point of our 3000 miles of coast line. It is obvious that a sufficient fleet could not be stationed at all points to repel such attacks. The greatest safety, therefore, would lie in providing a line of defence capable of holding an enemy in check until the various squadrons of the British fleet arrived at the scene of action. Under present circumstances the time that would be occupied by ships of war passing from one side of Britain to the other would render aid from the opposite side of the island to that upon which the attack was directed altogether impracticable, and, consequently, fleets, capable of meeting all emergencies, would require to be stationed on both sides. With the canal, however, as already indicated, all the available squadrons could, if necessary, be concentrated at any given point within a comparatively short period. Whether the enemy attempted to land, or adopted the tactics of intercepting merchant vessels, suggested by the German author, the great waterway would be equally efficacious in preventing invasion, and in protecting commerce, by enabling the British fleet to remain, more indisputably than ever, "master of the high seas."

INTERNATIONAL ASPECTS OF THE PROJECT.

CHAPTER XII.

THE DEVELOPMENT OF INTERNATIONAL TRADE.

THE SHIPPING *Nearly one-half of the whole merchant shipping of the*
OF THE WORLD. *world* belongs to the United Kingdom, while of the remainder, *one-half* belongs to those foreign countries upon the commerce of which the Forth and Clyde Ship Canal would confer direct advantages. At present the western ports, including those of Canada and the United States, in their shipping trade with the eastern ports, including those of the northern continent of Europe, are subjected to the dangers, delays, and frequent losses involved in the continual detours requiring to be made by their ships round the northern or southern extremity of the island. Notwithstanding the difficulties of these navigations, a very large traffic is carried on between the ports east and west of Britain. From a great part of the foreign shipping thus traversing British waters, the country derives no benefit, owing to the fact that no eligible opportunities are presented, along the barren northern coast, for the interchange of commodities. The opening, however, of a short and safe passage through one of the principal commercial centres of the island, would present such obvious facilities for trade, that a new and extensive source of supply and demand would be created. The Forth and Clyde Ship Canal, therefore, by surmounting a comparatively small physical obstacle on this natural international highway, and by thus conferring additional trading facilities upon the countries owning *three-fourths of the whole mercantile shipping of the world*, would contribute largely to the

increased prosperity of those divisions of the globe possessing the maximum of commerce and enterprise. In this respect the undertaking could claim advantages not shared by any other artificial waterway.

TABLE OF NUMBER AND TONNAGE OF MERCHANT VESSELS OF 100 TONS GROSS AND UPWARDS, BELONGING TO THE COUNTRIES THAT WOULD BENEFIT DIRECTLY BY THE SHIP CANAL.

Compiled from Lloyd's Register of Shipping for 1888.

COUNTRIES.	NUMBER OF VESSELS.	TONNAGE.
United Kingdom.	9,091	9,127,454
British Colonies, -	3,138	1,434,111
United States.	3,640	1,948,090
Norway, -	3,307	1,424,884
Germany, -	2,086	1,387,635
Sweden, -	1,465	458,034
Russia, -	1,228	430,300
Holland, -	593	368,747
Denmark, -	814	256,103
Total of above Countries,	25,362	16,835,388
Total of World, -	33,200	20,738,645

THE CHIEF Apart from the foreign traffic that would utilise the
MERCANTILE canal, an examination of shipping statistics tends to
NAVIES. show that the international trade of Britain alone would, almost certainly, yield a revenue sufficient to make the ship canal a highly remunerative undertaking. Mulhall says: "So great has been the increase of trade, in the last ten or fifteen years, that other nations have been unable to build vessels fast enough, and, but for British shipping, no country in the world (except Canada, Sweden, and Norway) would have sufficient vessels to carry on its commerce. The shipping of the United Kingdom (without colonial) carried in 1883 no less than 51 per cent. of the world's commerce." In view of the fact that Britain acts, to such a large extent, as carrier for all other nations, it is inexplicable that the natural facilities for the development of this great carrying trade, presented by the Forth and Clyde district, should have remained so long unutilised.

The following table shows that the extent and value of the merchant navy of the British Empire is nearly ten times greater than that of Germany or France; although the imports and exports of the United Kingdom are not much more than double those of the principal continental countries. This further proves that a very large part of the British fleet is devoted to transporting the merchandise of other countries, and that, therefore, every additional facility, conferred upon this fleet, will enable it the more steadfastly to maintain its position as chief carrier for the world:

TABLE SHOWING THE APPROXIMATE EXTENT, VALUE, AND TRADE OF THE PRINCIPAL EUROPEAN MERCANTILE NAVIES.

Compiled from Lloyd's Register of Shipping for 1888.

PARTICULARS.	BRITISH EMPIRE.	GERMANY.	FRANCE.
No. of Merchant Steamers (above 100 tons),	5,715	601	481
Gross Tonnage of Do., -	6,853,515	659,660	731,732
No. of Merchant Sail, -	6,514	1,485	998
Net Tonnage of Do., -	3,698,080	727,975	264,186
Approximate Value of Merchant Navy,	£93,000,000	£9,500,000	£9,000,000
Annual Imports (Approximate),	United Kingdom only.		
Annual Exports Do.,	£349,000,000	£144,000,000	£168,000,000
	£269,000,000	£149,000,000	£130,000,000
Total Annual Imports and Exports,	£618,000,000	£293,000,000	£298,000,000

According to Mulhall: "The amount of imports and exports of *all nations*, measured by value, has increased since 1850 no less than 283 per cent." That is to say, from £771,000,000 in 1850 to £2,913,000,000 in 1884. The increase in the above countries, in the same period, was as follows: Great Britain—from £193,000,000 to £686,000,000; Germany—from £105,000,000 to £331,000,000; and France—from £75,000,000 to £315,000,000. "If no change in prices had occurred, the trade of 1884 would have represented *four and a quarter times* the amount of 1850, that is, an increase of 326 per cent., or *twelve times greater than the progress of population*. But, if we come to consider the actual weight of merchandise carried between nations, we find that it has risen to *six times* the volume of 1850, owing to the fact that *reduced freights have permitted an extraordinary development of trade in articles of bulk and minor value*." Here we find, from what has happened during the past generation, the kernel of the arguments advanced in favour of this project, viz.—the development of trade in articles of bulk and minor value by the reduction of freights. This is the chief object in view in promoting this project. Manufacturers and merchants in this country are unable to compete with foreigners in many branches of trade, owing to the necessarily high railway freights for the transport of heavy materials. The ship canal, by reducing freights on heavy materials, would place the producers of the district upon a more equal footing with their foreign rivals, and enable them to uphold and improve their position. The attainment of this object would carry with it the financial success of the undertaking.

INTERNATIONAL That the island of Great Britain acts, to a large extent,
TRADE ALREADY as a barrier to international commerce is very strikingly
ESTABLISHED. exemplified by the Board of Trade returns of shipping,
which show that the commercial ports on the west coast of Britain receive a

large amount of shipping from America, while the ports on the east coast receive, comparatively, a very small quantity. On the other hand, the same returns show that the ports on the east side of the island receive a large number of vessels from northern Europe, while the west ports receive a greatly diminished number. This affords further and conclusive proof that the passage of the Pentland Firth, or of the English Channel, presents elements of cost, danger, and delay that deter a considerable proportion of British and foreign shipowners and merchants from extending the sea-going limits of their trade beyond these boundaries. It is thus evident that the west ports of Britain are deprived, to a very large extent, of the opportunity of trading directly with the ports of northern Europe; while the ports on the east are equally prevented from cultivating commercial relations with America. Were the ship canal available, the cost of transit to ports east and west of Britain would be reduced, dangers and delays would be diminished, and trade, generally, would be stimulated and developed. As an indication of the amount of international trade already established, and which would be benefited by the ship canal, the shipping returns for six ports on each side of Scotland and England, and six on the coast of Ireland, are here given :

TABLE SHOWING THE NUMBER AND TONNAGE OF BRITISH AND FOREIGN STEAM AND SAILING VESSELS, INCLUDING THEIR REPEATED VOYAGES, THAT ENTERED AND CLEARED AT THE FOLLOWING PORTS IN 1889.

Compiled from the Annual Statement of the Board of Trade on the Navigation and Shipping of the United Kingdom.

I.—Vessels Trading between Northern Russia, Sweden, Norway, Denmark, Ger- many, Holland, Belgium, and	Number of Vessels.	Tonnage of Vessels.	II.—Vessels Trading between Canada, the United States of America, and	Number of Vessels.	Tonnage of Vessels.
Glasgow, - -	344	240,873	Peterhead,	1	174
Grangemouth,	2,264	905,505	Aberdeen,	31	32,307
Greenock, - -	201	115,510	Montrose,	2	1,197
Ardrossan, - -	25	12,287	Dundee,	20	18,235
Troon, - -	51	23,235	Kirkcaldy,	2	487
Ayr,	18	4,446	Leith,	65	84,371
Barrow,	105	71,403			
Liverpool, - - -	1,380	753,208	Total,	121	137,071
Cardiff,	1,364	1,335,773			
Bristol,	266	131,759			
Swansea,	314	163,329	III.—Vessels Trading between	Number of Vessels.	Tonnage of Vessels.
Gloucester,	183	93,821	Canada and		
Belfast,	213	100,681	Tyne Ports,	50	57,840
Dublin,	182	78,518	Sunderland,	18	15,029
Cork, - -	85	26,414	Hartlepool, -	11	8,781
Waterford,	27	11,175	Middlesbrough,	5	6,588
Limnrick,	29	11,470	Hull, - -	11	10,703
Londonderry,	17	5,843	London,	294	356,850
Total,	7,068	4,086,330	Total,	389	455,791
			Grand Total,	7,578	4,679,192

These figures conclusively prove that the ship canal would be of great service to a large part of the international trade already established. It will be noted that the figures only show the trade between some of the principal ports of this and the foreign countries enumerated. We have to take into account, in addition, the coasting trade; the direct trade between the northern continental ports and America; the normal increase of the shipping trade; and the increase that would accrue from the facilities afforded by the canal itself.

In the above table Grangemouth is placed in the list of west ports, for the reason that, so far as this inquiry is concerned, it, practically, is a west port. The bulk of its trade depends upon the fact that it is, at present, the nearest landing point for consignments from the east for the industries of the west. On the question of the difficulties of the northern passage, and the consequent necessity for a ship canal, it is interesting to note that the port of Grangemouth in 1889 entered and cleared from and to northern Europe 2,264 vessels of 905,505 tons; while the port of Glasgow only entered and cleared from the same countries 344 vessels of 240,873 tons. This shows that some of the northern continental ports, at present, carry on an amount of trade with Glasgow alone that would furnish a nucleus of over 1,000,000 tons of traffic to the ship canal. The average cost of transporting the greater part of this traffic by rail, from the Forth to the Clyde, probably amounts to 10s. per ton. Including all charges £400,000 may be regarded as within the sum annually spent on this single branch of traffic—a sum in itself sufficient to yield a large dividend on the capital of the Canal Company. As this traffic could be conveyed by the waterway at a fifth of the cost by the railway, a correspondingly small proportion of the present estimated expenditure would accrue to the canal proprietors. The great augmentation of traffic, however, consequent on the reduction of the cost of transport, would, by stimulating the commerce of the country, yield, indirectly, larger returns both to the railways and the waterway.

The trade from west to east affords an equally strong argument in favour of a through passage. From the same returns it appears that in 1889 Glasgow entered and cleared from northern America 582 vessels of 1,090,180 tons, while Grangemouth had only 9 vessels of 6,873 tons from that quarter. The same position is observable throughout the ports on the east and west coasts—a position which renders it evident that the one side of the island is precluded, by the dangers and delays of the northern and southern passages, from that freedom of trade with the other side, and the countries beyond, which would inevitably follow were the ship canal a *fait accompli*.

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THE DIRECT
ROUTE BETWEEN
THE BALTIC SEA
AND THE
CANADIAN LAKES.

If a straight line be drawn across the map of the world on Mercator's projection, from a point at the entrance to the Baltic Sea, to the mouth of the river St. Lawrence, it will be found that *the line passes almost parallel with, and in close proximity to,* the proposed route of the Forth and Clyde Ship Canal. The entrances to the Baltic Sea and the river St. Lawrence form the respective gateways to the *markets of the interior of northern Europe and northern America.* This canal would, consequently, open up *the shortest possible sea route* between the capitals and business centres of Russia, Germany, Norway, Sweden, and Denmark on the one side, and the marts of Canada and the United States on the other. That an extensive trade is already established between the western ports—Quebec, Montreal, Toronto, Chicago, and the other cities and towns on Lakes Superior, Michigan, Huron, Erie, and Ontario; and the eastern ports—London, Hamburg, Christiania, Copenhagen, Stockholm, St. Petersburg, and the numerous ports on the North Sea and the Baltic Sea—is evident from the traffic annually passing through the Pentland Firth.

The *Ordnance Gazetteer* (1884) says: "Though the Pentland Firth is *the most dangerous passage in the British seas*, it must be traversed by all vessels passing from the east of Scotland to the Atlantic, or from the west to the North Sea, except those small enough to be accommodated by the Caledonian Canal, and hence over 5,000 vessels pass through every year in spite of the danger and difficulty of the navigation." Owing to the strength of the currents only vessels of considerable size, heavily laden, can venture to navigate this strait. We may, therefore, estimate the average measurement of the 5,000 vessels at 700 tons each—equivalent to an annual traffic, by the northern passage, of 3,500,000 tons. That this is a moderate estimate is evident from the fact that the average measurement of the 522 ocean-going vessels that entered the port of Montreal in 1889, many of which passed through the Pentland Firth, was upwards of 1,400 tons.

The average saving in distance by the proposed ship canal, as compared with the present route, would be about 500 miles. According to this calculation, therefore, the total saving in carriage and distance would be 1,750,000,000 ton-miles. At ½d. per ton per mile, which is moderate considering the dangers, delays, and losses by shipwreck, the cost of the unnecessary detour by the Pentland Firth is equivalent to over £1,800,000 per annum. The canal dues on 3,500,000 tons, the estimated traffic through the Pentland Firth, at ½d. per ton per mile of the canal—equivalent to 1s. 3d. per ton on the total mileage—would amount to about £220,000 per annum, showing a saving to shippers, by the adoption of the ship canal route, of over a million and a half per annum.

CHAPTER XIII.

BRITISH INTERNATIONAL TRADE ROUTES.

THE EAST COAST AMERICAN TRADE.

INFLUENCE OF THE NORTHERN PASSAGE. A certain amount of commerce presently exists between the east coast of Britain and American ports on the one hand, and the west coast and northern continental ports on the other. This commerce, however, is burdened and restricted by the serious risks incidental to the northern and southern passages. That these risks do deter shipowners and freighters from extending their connections, in the directions specified, can be conclusively demonstrated from the Board of Trade returns. That a number of shippers actually encounter these risks proves the eagerness to establish trade, and further tends to show that the shorter and safer passage would give individual traders an additional incentive to open up new foreign markets for British goods. In considering the advantages that this project would confer upon home ports, it is important to examine, to some extent, the resources available for commerce in northern America and northern Europe. The limits of the treatise will only admit of quotations from one or two authorities on either side. The Dominion of Canada, as a field for the enterprise of the east coast ports, is selected for reference.

CANADIAN MARKETS. Mr. Sandford Fleming, C.M.G., LL.D., engineer in chief of railways for the Canadian Government, member of the International Congress on Inland Navigation, in his paper to the Congress, says: "*Canada extends from south to north over thirty degrees of latitude, and from east to west over eighty-five degrees of longitude. Eastwards of the Atlantic the same parallels of latitude embrace the whole of Europe lying northward of Rome, and the same number of degrees of longitude extend from the western side of the British Islands to a meridian passing through the middle of India.* The great hydrographical basin of the St. Lawrence has a total length of navigation, from the Atlantic to the head of Lake Superior, of *nearly 2,300 miles.* Previous to 1850 the size of a ship trading to Montreal was limited to a depth of 11 feet. *At*

the present date a depth of 27½ feet of water is attained, admitting the passage of the largest class of ocean tonnage, at all states of the tide. These important river improvement works are on a scale which compare with similar operations on the Clyde and Schelde, and which have had so great an influence on the growth of Glasgow and Antwerp. Works are now in progress for a canal, which will complete the national system of waterways from tide-water to the head of Lake Superior, a distance of 1,370 miles. The Dominion Government is manifesting, in a very practical way, the determination to push forward the completion of the works of inland navigation with all possible speed. The responsible Minister has recently stated that the whole of the canals, including the new one at Sault St. Marie, will be completed for 14 feet navigation by 1892. The very multitude of the waterways is, indeed, one of the characteristics of the Dominion. It is not simply her unparalleled lakes, her noble rivers, navigable for so many hundreds of miles, it is the myriads of affluents, ramifying throughout the greater part of the wide domain, which have proved so valuable. It is owing to the judicious expenditure in improving river navigation that we may trace, to a large extent, the marvellous progress made by the inland provinces of Canada."

These excerpts indicate (1) that the Dominion of Canada, being larger than the whole of Europe, and possessing extraordinary facilities for cheap transport, presents almost unlimited fields for founding new markets and extending commercial relations; (2) that great attention has been paid by the Canadian Government to the extension of its waterways. The example of the Executive of Canada may influence the action of the British Government in the matter of this project; and (3) that the expenditure of the Canadian Government upon waterways has had a marvellously beneficial effect upon the prosperity of the country.

EAST COAST CATTLE TRADE. The cattle trade with Canada affords a striking illustration of the advantages that would be conferred upon the east coast ports by the ship canal. In a "special cablegram" from Montreal, the correspondent of the *Glasgow Herald*, in the issue of 28th November, 1890, referring to the consignments of cattle and sheep for the year, says: "Total, 120,654 cattle, 44,787 sheep; corresponding period in 1889, 85,396 cattle, 58,834 sheep. From the above figures it will be seen that *the increase in cattle exports has been most extraordinary*, exceeding that of last year by 35,258 cattle, and the year previous by 59,562. This remarkable development of our Dominion cattle trade is *chiefly due to the new outlets found for lean stock at Aberdeen, Dundee, and Newcastle*. Last year Aberdeen was credited with 9,500 cattle, whereas this year it ranks third, with a total of 17,500; Dundee being placed next to London with 9,200; while Newcastle, the latest addition to our shipping ports, comes last with the respectable total of 3,100.

News has just been received of *another serious loss on cattle consigned to Dundee ex Norse King*. Taken on the whole, *the season's trading has not been a very remunerative one.*"

Great efforts are being made by the east coast ports to place the cattle trade on a firm foundation. From this report, however, it appears that the storms, whirlpools, and eddies of the northern passage make these efforts, to a large extent, unavailing. There is consequently a strong probability that, in this trade, as in many others, the risks and losses will soon deter those engaged in it from pursuing the enterprise. It is obvious that the ship canal would be of the greatest possible service to the ports of Aberdeen, Dundee, and Newcastle in enabling them to maintain and develop this trade.

THE WEST COAST BALTIC TRADE.

THE PRESENT TRAFFIC. There can be no doubt that the construction of the proposed ship canal would give an immense impetus to, and establish upon a reliable basis, the trade now being carried on in a desultory manner between the ports on the west coast of Britain and the northern continental ports. At present there is a great and regular traffic between the ports on the west coast and America, and a comparatively small and irregular traffic by sea between the same ports and those on the North Sea. What is the explanation of the difference? The northern continental ports present greater facilities for trade, on account of their proximity, than the American ports. This is clear from the enormous volume of traffic between the former and London, Hull, Newcastle, Leith, etc. The explanation is again to be found in the dangers and risks of the Pentland Firth, which, though passable, nevertheless in its effect on the west coast trade amounts to an almost insuperable barrier. The irregular trade that now exists would form the nucleus of a vastly extended regular traffic if Glasgow had the same facilities for trading with northern Europe that it now has with America and other parts of the world.

The irregular character of the present trade is evidenced by the daily reports of shipping. At one time we find a considerable number of vessels trading between the west and the east, and at another time we find very few. For example, the shipping intelligence of the *Glasgow Herald*, 12th November, 1890, contains the following information: "Sailed from Glasgow, November 11, *Mineola* (s), 1582, Evans, Leith—inward general cargo. Arrived at the Tail of the Bank: *Mattekovits* (s), 1249, Randich, from Antwerp for Greenock—sugar; *Onsel* (s), 555, Fay, from Antwerp for Greenock and Glasgow—

general; *Greata* (s), 288, Taylor, from Gottenburg for Glasgow—general. Sailed from the Tail of the Bank: *Hermod* (s), Helmblad, from Glasgow for Gottenburg—coal, etc. Dundee: Arrived—*Princess Helena* (s), Liverpool—goods. Liverpool: Arrived—*Westmoreland* (s), Hamburg; *Ping* (s), Antwerp; *Avocet* (s), Ghent. Sailed—*Lestris* (s), Antwerp; *Bittern* (s), Amsterdam. Arrivals at foreign ports: *Brodrene* from Glasgow at Christiania. Sailings from foreign ports: *Serica* (s), left Quebec for Dundee." It is evident that the day's traffic, above enumerated, would have benefited by the ship canal, and we have here another indication of the international trade that awaits the opening of the waterway.

RUSSIAN In order to form an estimate of the fresh fields for
MARKETS. commerce that the ship canal would present to the
enterprise of the western ports of Britain, it is necessary to study the trade
and trading facilities of Russia, Germany, Sweden, Norway, Denmark,
Holland, and Belgium. The present limits, however, preclude more than a
reference to the Russian and German markets. In Russia we find a *water
navigation for vessels extending to over 18,000 miles*, and for rafts to over
37,000 miles. The rivers of Russia, with their branch canals, *bring im-
mense quantities of raw materials to the Baltic*, from all parts of the vast
empire, and carry away manufactured products in exchange. The extra-
ordinary ramifications of trade in this country will be gathered from the
fact that *the Baltic is united to the Caspian Sea by no fewer than three
separate systems of canals*, and, furthermore, that the Baltic has com-
munication with the Black Sea by an equal number of different water-
ways. Ships, loaded in the Caspian Sea, can ascend the Volga and pro-
ceed hence, by various rivers and canals, direct to St Petersburg with-
out unloading cargo. M. Nicolas de Sytenko, representative of the
Russian Government to the International Congress on Inland Navigation,
in his paper to the Congress, says: "Although, from the birth of civili-
sation, navigable waterways had been believed to offer the most conveni-
ent means of transport, on the invention of railways they were obliged
to yield their position, and, to a certain extent, to fall into the back-
ground. The State gave itself up to the development of the railways, but
as *the cost of transport is, commercially, one of the most important
factors swaying the price of products*, and as the possibility of a great
concentration of tonnage and of transport to long distances, and in large
quantities, constitutes the characteristic quality of navigation, and *has
influence on the diminution of charges for transport*, it becomes quite
comprehensible that *the natural result of the development of railways
must be the development and increase, in the same proportion, of the
navigable waterways*. In the same manner must result the necessity of
improving and perfecting the canals connecting the navigable rivers to
meet the ever-increasing exigencies of commerce, of industry, and of

agriculture. In fact, the rapid and natural development of inland navigation is likely again to attract the attention and enlist the cares of the *Russian Government, which, recognising that the normal relations that must exist between railways and waterways do not point to competition but to combination, has taken most energetic steps towards the fundamental improvement of the existing navigations and the regulation of the modes of working them.* During the last ten or fifteen years (but more especially during the last three or four years) *the Russian Government, and also the Governments of other countries, have busied themselves with considerable activity in the improvement of both natural and artificial waterways.* To be able to make more perfect improvements, and, at the same time, to avoid the errors so frequent in such cases, *the Russian Minister of Ways of Communication, has, from the year 1875, been engaged upon a survey of the great rivers and lakes of Russia in Europe.* The results of all these surveys, which the Government publish as they are completed, along with the information acquired, will help to form an adequate foundation for the radical measures necessary for the improvement of the immense navigable waterways of Russia.

“According to the register of 1866, the total number of vessels engaged in inland navigation was 22,000; their money value may be estimated at 257,500,000 francs, and the number of their crews at 120,000 men. Besides this an average number of 94,300 rafts of timber use these waterways, representing also as much merchandise as wood. If we add to this, that *there are more than 32,500,000 tons of goods annually carried,* we can easily form a general idea of the immense importance to Russia, both of her navigable waterways and of her inland fleet. *In 1852 the number of steamers on all the navigable waterways in European Russia was estimated at only 83. But since that time the number increases by gigantic leaps.* In 1856 it was doubled, being 163; and 30 years later, according to the register of 1886, it was 1,507; and its cost value was estimated at 866,306,576 francs.

“The Neva, proceeding from Lake Ladoga, one of the largest in European Russia, and also serving as an outlet for the basin of the Volga and the basin of the lakes, empties itself into the Gulf of Finland close to St. Petersburg. *Having thus opened, to the most distant parts of the empire, an outlet for its produce, into an open sea accessible to universal commerce,* the Neva occupies an important position amongst the commercial ways, owing to the enormous movement of its merchandise, and transforms the capital of *St. Petersburg into a commercial port of the first rank.* This river constitutes an excellent means of navigation, which needs no improvement, and on which shipping can prosper without difficulty. According to the reports of trade, the Neva is very favourably situated, since all the cargoes which come by lake or canal, after reaching the source of the river near to Chlisselbourg, descend its course towards St. Petersburg, and by this means the traffic is very rapid. *During*

last year (1889) 3,300,000 tons of merchandise arrived at St. Petersburg by means of the river. The three previous years show an average of 3,400,000 tons, of which more than one million consisted of grains and cereals belonging to the basin of the Volga. The number of vessels arriving at St. Petersburg by the Neva during the past three years showed a mean of 14,050, besides 1,500 rafts."

M. de Sytenko's paper has been quoted at considerable length on account of the important bearing which it has upon the various aspects of this project. It is very forcibly stated (1) that the development of railways must result in an equal increase of navigable waterways; (2) that railways and waterways should combine for mutual benefit; (3) that Governments are now beginning to turn their attention to the development of waterways rather than of railways; (4) that the Russian Government have instituted a national survey of waterways; and (5) that the trade of Russia has developed enormously by means of its waterways within recent years. The paper proves that the rapid development of trade between the vast interior of Russia and the Baltic Sea offers to the shippers of the western ports of Britain innumerable opportunities for founding new markets and extending the already established trade. It is obvious, however, that these opportunities can only be made properly available by the opening of the ship canal.

GERMAN MARKETS.

A great trade is carried on between Britain and Germany. In this trade, however, the west coast ports of Britain have a very small share. The risks of the northern and southern passages confine the trade almost exclusively to the east coast ports. The construction of the ship canal, by opening up the markets of the great industrial nation of the continent to the enterprise of Glasgow and the west coast ports, would inevitably lead to a rapid augmentation of the commerce between the two countries. That Germany presents a marvellous and practically unlimited field for the extension of trade is shown by the following statistics:

Herr Sympher, engineer to the German Government, member of the International Congress on Inland Navigation, in his paper to the Congress, referring to the development of commerce in Germany, says: "The goods traffic is very heavy. It is shown by the figures for 1885 that *4,800,000,000 tons of goods were carried along the waterways*. A comparison of the figures shown in the tables for the years between 1875 and 1885, proves *the extraordinary development* of the internal navigation within the German realm. For whilst the length of the canals and rivers remained about equal, that is, 10,000 kilometers, the tonnage rose from 2,900,000,000 to 4,900,000,000, in other words, 66 per cent. In this growth the large rivers only share to any perceptible extent. The smaller waterways and others, lying along less frequented routes, are practically at a standstill. *The fact that the large capable rivers which have been deepened have greatly increased*

their traffic, is of the highest importance in considering the construction of new waterways. From the fact that the large waterways are able to show a great increase in their traffic, we see that only such waterways as are able to accommodate heavy ships are needed in Germany. What Germany wants is large capable waterways in the right places, such as connections between our large cities and centres of industry and our large rivers. Smaller waterways may satisfy local demands, but they have no further importance. We see further the immense value of the improvements which have been made, and how well the cost has been applied. The Elbe and the Oder shared heaviest in the improvement, and they, too, show the heaviest increase in their traffic. It is surely without a parallel in history that a means of communication, which has existed for centuries, should treble its traffic in ten years, and this with a very minimum of outlay. How many millions may yet be spent profitably before the resources are exhausted, and before any want of return need be feared? When the great centres of industry and trade are connected, when the too frequent intermediate costs of transmission between railway and vessel are a thing of the past, and no longer lessen the profits derived from the waterways, then and not till then, shall we understand the true value of vessel carriage. Only a few years ago such a prospect seemed hopeless in Germany, but the more the attention of the nation and the Government is directed to the waterways, the more these ways are improved and new ones made, the more these improvements are attended with good results; the more the true value of the waterways is made plain and recognised, the more we feel convinced that the development of the railway will be followed by the development of the waterway, and that in Germany, with her large natural means of communication, a new impulse will thereby be given to industry."

The inconceivably large traffic on the waterways of Germany shows the beneficial influence of these waterways on the trade of the country, and account, to a large extent, for the high position that it has attained amongst the commercial nations of the world. Herr Sympher's paper supports several of the arguments advanced in favour of the construction of the Forth and Clyde Ship Canal, amongst these it may be noted: (1) That canals in the right places, capable of accommodating large ships, greatly increase commerce and become financially successful; (2) that the connection of centres of industry, and the abolition of the costs of unnecessary intermediate carriage increases profits and stimulates trade; and (3) that the more the attention of the British nation and the government is directed to the great natural advantages of central Scotland for the development of commerce, the more convincing will become the evidence that "the proposed waterway would increase the volume of commerce, aid in maintaining and protecting that commerce against foreign competition in times of peace, and foreign acquisition in the event of war; and that it would also in itself prove a highly remunerative undertaking."

THE EMPEROR WILLIAM II. A Reuter's telegram from Berlin, dated 25th November, 1890, announced in this country that His Majesty the Emperor of Germany, on the previous day, at a meeting of Parliamentary Deputies convened by the Imperial Chancellor, General Von Caprivi, "*urged the necessity of developing and improving canal and river communications within his dominions ; observing that waterways were of importance from the military as well as the commercial standpoint.*"

"Bid harbours open, public ways extend;
Bid temples worthier of God ascend;
Bid the broad arch, the dangerous flood contain,
The mole, projected, break the roaring main;
Back to his bounds, their subject sea command,
And roll obedient rivers through the land.
These honours peace to happy Britain brings;
These are Imperial works and worthy Kings."—*Pope.*

APPENDIX.

REPORT ON THE SURVEY OF THE ROUTE OF THE PROPOSED FORTH AND CLYDE SHIP CANAL.

BY MESSRS. CROUCH & HOGG, CIVIL ENGINEERS, GLASGOW.

To the Provisional Committee of the Forth and Clyde Ship Canal.

GENTLEMEN,—

1. Since receiving instructions from your Secretary, Mr. J. Law Crawford, to report upon the feasibility of constructing a ship canal between the Forth and the Clyde, and to furnish an approximate estimate of its cost, we have studied a variety of information bearing on the subject, and have made surveys of the district.

2. Our instructions did not, of course, contemplate the elaborate study of details which would be necessary before putting forward an undertaking of such magnitude as completely worked out in all its parts; but in laying our plans before you we believe we are in a position to give sufficient information for guiding you as to the advisability of attempting to take action in the promotion of a scheme of this nature.

3. Before proceeding to refer to the plans laid before you with this report, it may not be uninteresting to glance at the history of the project of a canal for connecting the rivers Forth and Clyde.

4. Some scheme of this nature was originally proposed in the reign of Charles II. but there does not appear to be any record of its having taken any practical shape until the year 1723, when a survey was made, with the result that the undertaking was considered one of such magnitude that no steps were taken to carry it further.

5. The project was, however, revived from time to time, and various engineers of eminence, amongst whom were Brindley and Smeaton, were consulted on the subject. Considerable difference of opinion prevailed then, as now, on the question of the two alternative routes, which may be generally described as—

(a) The direct route.

(b) The Loch Lomond route.

Finally, however, the advice of Smeaton, who very strongly recommended the direct route, was adopted in 1767, and an Act of Parliament was obtained in 1768 for the construction of the existing canal.

6. The work of construction was commenced in the same year, and five years later, in 1773, the canal was opened for traffic from Grangemouth to Kirkintilloch. In 1775 it was extended to Stockingfield, near Maryhill, and in 1777 the branch to Hamilton Hill was finished. The portion from Maryhill to the Clyde was commenced in 1786, and the canal was completed throughout to Bowling in 1790, exactly 100 years ago.

7. The nominal depth is 10 feet, but the navigation is restricted to vessels drawing not more than 8 feet 9 inches; the summit level is 158 feet above Ordnance datum; the size of the locks is 70 feet by 19 feet 8 inches in the clear, and there are 39 in all between the Forth and the Clyde.

8. In 1846 the Monkland Canal was amalgamated with the Forth and Clyde navigation, and by an Act of 1867 this navigation became vested in the Caledonian Railway Company, the proprietors receiving from the railway company an annuity of £71,333 6s. 8d., being a guaranteed dividend of $6\frac{1}{2}$ per cent. per annum on a capital sum of £1,141,333 6s. 8d.

9. Without entering into a discussion of the comparative merits of the two routes above-mentioned, it is sufficient for the present purpose to say that, after a preliminary examination of the main features of both, we formed a very decided opinion as to the superiority of the "direct route," and we have, therefore, confined our studies entirely to it.

10. One of the most essential points to be considered in selecting a line for the proposed canal is the summit level to be adopted, which it is, of course, of great importance, should be as low as is consistent with keeping the amount of excavation within reasonable limits.

11. As suggestions have been made on the subject, we may say that in our opinion the cost of making a cut free from locks, or other methods of raising vessels, would be quite prohibitory, and that, therefore, at a very early stage of our investigations we abandoned any idea of the kind.

12. The summit level, which, taking all the circumstances into consideration, we have considered it best to adopt, is 95 feet above Ordnance datum. The level of high-water ordinary spring tides above Ordnance datum is 5 feet in the Clyde and 10 feet in the Forth, the lift therefore to the summit level from high water would be 90 feet from the former river and 85 feet from the latter.

13. While we have not lost sight of other methods of raising vessels which have at various times been suggested, and in some cases put into operation in place of locks, we have not seen our way to adopt any of them in our plans and estimates in preference to the latter.

14. The adoption of locks of course involves the necessity of a large supply of water (a portion of the subject dealt with hereafter), and also delay in the passage of vessels, but in this respect we are very strongly disposed to think that, even if practicable, any other method of raising vessels would be open to equal, if not greater objection.

15. The dimensions of the channel which we have adopted in our plans and estimates are a bottom width of 100 feet, and a depth of 26 feet. The surface width would of course vary according to the material, but the minimum in rock cutting with slopes of $\frac{1}{2}$ to 1 would be 126 feet.

16. We have in our estimates allowed for double locks, one being 600 feet long and 65 feet wide, and the other 400 feet long and 40 feet wide, and they would be subdivided by additional gates.

17. The minimum clear headway of bridges over the canal we have taken at 75 feet, which is the same as on the Manchester Canal.

18. Having now explained the main features that have been kept in view in selecting a route for the proposed canal, we may proceed to describe the line we have adopted, which is shown on the plan accompanying this report.

19. Leaving the river Clyde between Clydebank and Yoker, the line runs in an easterly direction along the valley of the Yoker Burn, crosses the existing Forth and Clyde Canal and the Helensburgh Railway, and cuts into the valley of the Kelvin near Garscube Bridge. From this point it follows the course of this valley, passing Kirkintilloch and Kilsyth to Kelvinhead, which is the summit between the two watersheds. It then enters the valley of the Bonny Water, the course of which it follows, passing Bonnybridge, down to the junction of that stream with the river Carron. From this point it runs due east to Grangemouth, and joins the Forth at the mouth of the river Carron.

20. The total length of the canal from the commencement to the termination above-described is 29 miles, 6 furlongs, 196 yards.

21. The positions of the locks, of which there are twelve, are shown on the section. Starting from the Clyde the first lock from the basin into the canal, which would have a depth of 20 feet below low water on the cill, has a lift of 10 feet above ordinary high water, or to 15 feet above Ordnance datum. The next lock is on the north side of the Clydebank Railway, and there is then a flight of four locks near Garscube. These five last-mentioned locks, which have a lift of 16 feet each, rise up to the summit level of 95 feet above Ordnance datum. This level extends from near the point where the canal enters the Kelvin valley to Bonnybridge, a distance of $17\frac{1}{2}$ miles, and between the latter point and Larbert there is a flight of five locks, between which the lift of 85 feet from ordinary high-water of the Forth is equally divided.

22. The river Carron would be canalized between Larbert and Grangemouth, the water-level being that of the ordinary high-water spring tides in the Forth, and we propose to have a tidal lock at the end of the canal where it joins the low-water channel of that river, which would have a depth of 15 feet below low water on the cill. The new channel for the river Carron would afford a very much better access than the present one to the Grangemouth Docks, and the proposed arrangement would save the expense, which is very considerable, of the constant dredging now required to keep the channel open.

23. The line of canal we have described necessarily crosses several railways, but there would be no very serious physical difficulties in dealing with them. They are as follows :

- (1.) North British Clydebank Railway.
- (2.) North British Helensburgh Railway.
- (3.) Kelvin Valley Railway.
- (4.) North British Campsie Branch.
- (5.) Caledonian Denny Branch.
- (6.) Caledonian Main Line.

24. For these swing bridges would be required in only two cases, viz., No. 1 and No. 4. In the case of No. 3, while a swing bridge would probably be the most economical method of dealing with it, it could by a diversion be carried over the canal, and in all the other cases the railway could be carried over the canal with the headway above-mentioned, without any alteration of level that could be open to serious objection.

25. Two private railways would also cross the canal by swing bridges, one near Kilsyth belonging to Messrs. W. Baird & Co., and another near the Carron Iron Works belonging to the Carron Company.

26. The existing canal would not be interfered with except at the point of crossing, where there would be a diversion and rearrangement of the positions of two of the locks upon it, in order to obtain a higher water level at the point of crossing. It might also be advisable to divert it near Castlecary, in consequence of the excavation for the ship canal being very near to it, in rather hoggry ground, but this is only a detail of construction.

27. As regards roads, several would of course cross the canal, but no engineering difficulties would arise in dealing satisfactorily with them.

28. One of the main objections which has frequently been urged to the direct route with locks is the assumed insufficiency of water supply, although we are not aware of any facts which have been adduced in support of that assumption. It is obviously a most essential point, and it may be admitted that if this objection were sustained it would be fatal to any scheme of the kind.

29. After careful investigation, however, we do not consider that there are any good grounds for such an assumption, and we will briefly state the reason for this opinion. We find that with the proposed summit level of 95 feet above Ordnance datum, the following waters will be available :

The river Kelvin, from its source to a point near Killermont House, including its tributary streams, viz.: The Glazert Water, the Luggie Water, the Allander Water, and several small streams flowing into them.

The Bonny Water, from its source to a point near Bonnybridge, together with its tributary the Red Burn, and several small tributary streams.

30. It is unnecessary to burden this report with details of our calculations, but we can state as their result that we consider from the portion of the area bounded by the watershed of these waters, which would be available for the proposed canal, an annual supply of upwards of 3,000,000,000 cubic feet of water, or say 10,000,000 cubic feet per day, may be reasonably assumed as obtainable, after making due allowance for compensation, absorption, and evaporation, and taking, as the basis of the calculations, the average rainfall of three consecutive dry years.

31. Although in this calculation we have made a very large allowance for compensation water, it may be mentioned that the water from these streams would only be taken into the canal after passing the mills which at present use it. Reservoirs would, of course, be required for the storage of flood waters, and it might probably be advisable

to give an additional height of about two feet to the lock gates at either end of the summit reach of 17½ miles, which, being considerably below the flood level, would act as a regulating reservoir.

32. A very large additional supply could also be obtained should it be required by impounding the head waters of the Carron and the Endrick, which could be made available for the canal by constructing a conduit through the Kilsyth Hills.

33. While, therefore, we cannot profess to have made more than a general investigation into this part of the subject, we feel some confidence in expressing the opinion that the necessary supply of water would be by no means an insuperable difficulty.

34. In this connection the question naturally arises for what amount of tonnage the above-mentioned quantity of 10,000,000 cubic feet per day is likely to suffice. This, of course, depends to a great extent on the size of the vessels passing through the canal, as also on whether vessels pass alternately in either direction.

35. It was stated in the evidence given in 1883 before the Committee on the Manchester Ship Canal that the total number of registered steamers in the United Kingdom was 5814, and that only 214, or about 3½ per cent., were over 2000 tons net register, and it appears from Lloyd's Register of 1888-89 that the proportion is now between 5 and 6 per cent.

36. It may probably be assumed that the largest proportion of vessels passing through the canal would be between 200 and 1,000 tons net register, and for these a lock of 300 feet long is the maximum required.

37. The traffic, on the average, may be fairly expected to be almost equal in each direction, but it cannot of course be assumed that vessels would pass through the locks in alternate directions, an arrangement that would require the minimum quantity of water, nor would it be reasonable to estimate for all vessels going in one direction, which would require the maximum quantity.

38. Taking, however, the mean of these, and what we think is a fair average of the size of vessels, we have arrived at the result that this quantity of 10,000,000 cubic feet of water per day would suffice for the lockage of 6,000,000 net registered tons per annum.

39. In this calculation we have not taken into consideration the saving effected by the adoption of the system of double locks, which allows of water being passed out of one lock into the other, and which in the case of the Manchester Canal is estimated at one-third, but have left it to cover leakage and waste.

40. In the event of a further supply of water being required, the head waters of the Carron and the Endrick could, as pointed out above, be made available at a moderate cost, and this additional supply would admit of a very much larger tonnage being passed through the canal.

41. As regards the estimate of cost, we have made as near an approximation to it as the information at our command will allow. On some portion of the route we have

been able to obtain the results of borings, and even on portions where we have not had this advantage, an examination of the country enables a fairly good idea to be obtained of the material likely to be met with in the excavation.

42. As will be seen from the section there would be some very heavy cutting for a length of about two miles near the Clyde end of the canal, and this would be principally in sandstone rock, but the rest of the cutting would probably be principally through gravel and glacial drift, with a short length of whin cutting, and our estimate of the earthwork is based upon this assumption. We have the means of arriving at a very close estimate of the cost of the locks, from the cost of very similar works elsewhere. The railway, canal, and road crossings can only be dealt with generally, but we believe we have arrived at a fair approximation to the cost of the works these would involve. To these items we have added what is as far as we can judge a liberal allowance for accommodation works, reservoirs, and contingencies; and our total estimate for works is £6,000,000.

43. The land which would be required, with the exception of that in the neighbourhood of Glasgow, is mainly agricultural, and we are disposed to think that about £500,000 is a sufficient estimate, but on this point we have not been able to go into as much detail as in that of works.

44. In connection with the land it may be mentioned that for a length of several miles in the valley of the Kelvin, where a large tract of land is subject to frequent floods, the construction of the canal would be a great benefit, as it would have the effect of lowering the water level, and carrying off the flood waters.

45. In concluding this Report, we beg to say that we do not profess to have made an exhaustive investigation of the various matters dealt with in it. The subject is one as to which a very large amount of information and careful observations on many points are essential to admit of anything more than a general opinion being given, but after a very careful consideration of such information as, within the limits of our instructions, we have been able to obtain, we feel justified in expressing the opinion that the construction and working of a ship canal along the route described is perfectly practicable, and that the cost would not exceed seven million pounds.

We are, GENTLEMEN,

Yours faithfully,

(Signed)

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WM. CROUCH.

C. P. HOGG.

175 Hope Street, Glasgow,
26th May, 1890.

REPORT ON THE MINERALS, IN THE CARBONIFEROUS LIMESTONE SERIES,
UNDERLYING THE DISTRICT OF THE PROPOSED FORTH AND CLYDE
SHIP CANAL.

By JAMES DUNCAN, ESQUIRE OF TWECHAR.

TWECHAR,

KILSYTH, 6th February, 1891.

J. LAW CRAWFORD, Esq., Writer,

146 West Regent Street, Glasgow.

DEAR SIR,

As desired, I have pleasure in furnishing you with the following brief summary of the results of more than twenty years' study of the stratigraphical arrangement of all the valuable seams of blackband, ironstones, and coals, and of the collection of many hundreds of sections, along the route proposed for the Forth and Clyde Ship Canal from Larbert on the east to Maryhill on the west.

A complete section of the stratigraphical arrangement of the minerals in the carboniferous limestone series has been prepared by Mr. Todd, from the statistics compiled by me, and I have authorised him to hand it to you with all necessary information, in order that it may accompany your work on this great project. I believe the section will be of practical service to those engaged in the mining industry, and of interest to those in any way acquainted with the geology of the district. Its graphic delineation of the numerous seams of coal and other minerals should strongly tend to convince the public of the great importance to commerce of a ship canal through the Kelvin valley, and of the large revenues that would be derived by the canal company from the transport of the productions of the mines of the district. A reference to the section will make the following observations readily understood :

Beginning at Larbert, on the east, the first point to be noted is near Larbert Station. This is within the area of what is known as the Falkirk coalfield. There are two workable coal seams here belonging to the lower section of the Airdrie coalfield. These seams are still undeveloped, and, as no pits are near, will probably be found to extend over a large area.

Next in importance, to the westward, is the Banknock coalfield. While the upper coals of the Airdrie section have mostly been exhausted here, there are still large deposits of the coals of the middle and lower sections, and at Coneypark, adjoining, of the lower.

After leaving Banknock coalfield the neighbourhood of Auchincloch is reached, and from this place westwards to Jordanhill the whole of the various seams of blackband ironstones and coals are found to lie in the carboniferous limestone series of strata. At Auchincloch, the coal nearest the surface is what is known as the Hirst coal, and it is the highest workable seam in the above series of strata. This coal has been worked on the Cumbernauld estate on the south side of the present canal for centuries, but there are still unworked several hundred acres on the north side of the canal. The expression, "highest workable seam," should be remembered, as the true meaning and significance of it will be explained afterwards, when the section at Alton, near Milton of Campsie, comes under consideration. At Gateside and adjoining lands coals on a lower level come nearest the surface, and the same thing occurs until Kilsyth is reached.

Merely glancing to the north at the coalfields of Riskend and Neilston, where large quantities of coal are still available, on the south there is the 400-acre field of Nethercroy, newly opened up, in relation to the position of the ironstones and coals in the sections at Cadder, Possil, and Maryhill, containing both blackband ironstones and coals, its northern extremity reaching to the Kelvin. The valuable coal and ironstone seams of the Kilsyth mineral field lie in the middle section of the lower coal measures under the index limestone. To the west of the town there are at least two valuable coal seams, besides blackband ironstone; but at Twechar, still farther to the west, there are at least six workable seams of coal, as well as ironstone. The true position of the Bannockburn series of coals in the carboniferous limestone strata was first unmistakably determined by a section at Twechar. The annual yield of minerals from this district alone will considerably exceed 300,000 tons, the larger part being coal.

From this point westwards, to near Maryhill, the whole mineral field of the Kelvin valley is still undeveloped.

The next section to be considered is that at Alton, near Milton of Campsie. A slightly diagonal line drawn from here to the town of Kirkintilloch will pass near the confluence of the rivers Kelvin and Glazert, to the north of Broomhill Homes. Only two points on this supposititious line need be noticed—the north point and the centre. At Alton the *Hirst*, or “highest workable seam,” of the carboniferous limestone strata is nearest the surface, 85 feet deep; but a section has been got which pierces the strata from the surface to a depth of 1,032 feet. The strata are perfectly normal; there are no indications of dislocations or of intrusive basalt. An examination of this deep section is both very interesting and instructive. The upper section of the lower coal measures is passed through, and a considerable portion of the middle section also. The result is that in the middle section the positions of the ironstone and coal seams are found to be identical not only with those of the Kilsyth mineral field proper, but also with those of Cadder, Possil, and Maryhill. The true meaning and significance, therefore, of the *Hirst* coal being found nearest the surface, as has been mentioned, at Auchinloch and Wester Shirva, and will be further mentioned in two sections yet to be considered, is this, that, judging by this section, all the more valuable seams will be found in a lower position or deeper down.

The extent of this mineral field rivals that of Kilsyth west of the town, and, without going into minutiae, it may be said to extend to at least four square miles. Now, the question may very naturally be asked: How has this great mineral field remained so long undeveloped? for, with the exception of a few boatloads of the *Hirst* seam taken from a pit put down on the west side of the farm—stead at Alton, all its mineral resources are intact. The answer is easy. It is simply a question of depth, for where the higher seams are on the top the depth to the more valuable is greater. It is now understood that a well-known firm of ironmasters who actually made the section which has been under consideration, many years ago, have now re-leased a portion of this mineral field, and operations are likely to be commenced shortly for opening it up.

More than a mile to the westward of Alton two sections have been obtained, one on the estate of Hayston and one on the estate of Carlston. Both these estates practically belong to the Alton mineral field. Take Hayston first. The section lies to the north away from the valley of the Kelvin, and here again the *Hirst* coal is nearest the surface—15 feet deep. On Carlston, to the west, on the other hand, the section reaches the metals about 190 feet below that seam. There are, therefore, varying depths to the valuable seams of the middle section of the lower coal measures.

West of Torrance of Campsie, at one point, there appears to be near the line of the river Kelvin a surface depth of 276 feet, but farther to the north it is only 50 feet, consisting of sand and clay. The middle section of carboniferous limestone strata is here reached at 264 feet from the surface.

The Cadder coal and ironstone field lies to the left, above the deeper valley of the Kelvin. Here the coal nearest the surface is, as a rule, what is called the Possil upper main coal, but along the Kelvin valley it is known under a variety of names. In geological sections it is called the Kilsyth coal (not the Kilsyth coking coal, mark), the Twechar upper coal, the Gartshore coal (also from geological sections), the Meiklehill steam coal, and it may have others besides, but its original name was the Possil upper main coal, and so it ought still to be called.

The Cadder mineral field does not dovetail into the Kelvin valley field proper, for it is separated from it by a deep down-throw to the north. This down-throw commences as far to the east as Gartshore, due south of Twechar, and continues at least as far as Blackhill on the

Bowling Canal. The section at Blackhill is the next and last to be considered. This section, like the one at Alton, shows the Hirst or highest workable coal, in the carboniferous limestone strata, to be nearest the surface; and fortunately it has been bored down to a sufficient depth to instruct that, as at Alton, the valuable seams of the middle section are found below. Here there are unmistakably the valuable Possil upper main coal, and three seams of black-band ironstone in positions that are quite well known throughout the whole extent of the valley; and other valuable seams lie deeper.

The following seams of ironstones and coals, given in a descending scale, beginning with the highest, have been found in various sections, of a workable thickness, within one mile and a quarter of either side of the river Kelvin: Hirst coal, Hirst smithy coal, Chapelgreen coal, Garscube coals (upper and lower), No. 1 BB ironstone of Geological Survey, coal above upper main, Possil upper main coal, Possil BB ironstone (free coal in east section), Possil main BB ironstone, Possil bottom BB ironstone, Bannockburn smithy coal, Bannockburn main coal, Bannockburn under coal, Possil "wee" BB ironstone, Possil main coal, Possil lower BB ironstone, unnamed coal, Possil cloven coal, shale coal, Knightswood gas coal, unnamed coal, Banton or Govan BB ironstone, Garibaldi OB ironstone, coal "wee" above coking coal, Kilsyth coking coal, Banton smithy coals (upper and lower), Johnstone CB ironstone, Hurlet coal. All these seams occupy well-defined positions, underlying the Hirst or highest workable seam.

In conclusion, I wish simply to point out that, apart from the great increase in the exportation of minerals that would certainly follow the opening of the canal, sea-going steamers could coal in the canal itself, with the best steam coal in Scotland, at the very pit-mouth, an arrangement which would pay both coalmasters and shippers, as well as the Canal Company.

I trust that you will carry this great national question to a highly successful issue.

I am,

Yours faithfully,

(Signed) JAMES DUNCAN.

REPORT RELATIVE TO THE MINERALS ON THE ROUTE OF THE PROPOSED FORTH AND CLYDE SHIP CANAL.

BY MR. JOHN TODD, MINING ENGINEER, KILSYTH.

J. LAW CRAWFORD, ESQ., Solicitor,
146 West Regent Street, Glasgow.

KILSYTH, 20th October, 1890.

DEAR SIR,

In compliance with your letter of the 20th ultimo, I now submit a report as to the minerals on the route of the proposed Forth and Clyde Ship Canal. Having studied the geological plans, bores and sections of the district, I am of the opinion that there is an undeveloped coal-field between Maryhill and Kilsyth, which has an area of about 9,000 acres. In this the carboniferous coal

measures are well represented, and contain various seams of coal which may yield over 100 millions of tons, a quantity almost as large as that estimated by the Royal Commission (1866-71) to be in the whole of Stirlingshire. This is accounted for by the value of the coal deposits being unknown at the time the Royal Commissioners submitted their estimate.

These seams are worked in the vicinity of Kilsyth; the daily output is about 1,000 tons, so that it is obvious that the production from the district is capable of very great extension beyond the present output, and cannot be exhausted for a very long period.

The quality of the coal embraces excellent coking coal, as well as that suitable for steam and household purposes. The Kilsyth main coking coal is well known, and highly esteemed, owing to its being the best of Scotch coal, and its similarity in quality to that of English coal, which fuses together and burns in a compact mass. This quality is well recognised in the products of Kilsyth seams, of which large quantities are manufactured into coke.

I may say here that the quality of the coal enables thin seams to be worked to as much profit as thicker ones in the Hamilton district.

The upper seams may be found at depths varying from 100 to 180 fathoms. The lower ones underlie this about 90 fathoms—a depth seldom reached in Scotland. This may account for the minerals being undeveloped, but when coal at shallower depths becomes exhausted, the resources of this district will doubtless join in the general progress of the country.

There are several seams of blackband ironstone of fine quality and thickness, but at the present time these may be considered as of no value to the undertaking. Looking, however, to the fact that the district is rich in coal and ironstone, it is only reasonable to expect that works may be erected along the banks of the canal which would be a great source of traffic. From Kilsyth to Larbert the canal passes through a large mineral field in the carboniferous series, which, for the most part, underlies a thin layer of the millstone grit; but it has not been sufficiently proved to admit of a calculation being made as to the quantity of coal which will probably be found. It may, however, contain the same seams as occur in the Kelvin valley.

By a somewhat curious geological formation, the household coals, which are the main seams of Airdrie and Coathridge, are found in the lands of Coneypark and Banknock covering an area of about 1,000 acres, in which there may exist a quantity of coal equal to seven millions of tons.

Yours faithfully,

(Signed) JOHN TODD.

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PLATE III.

